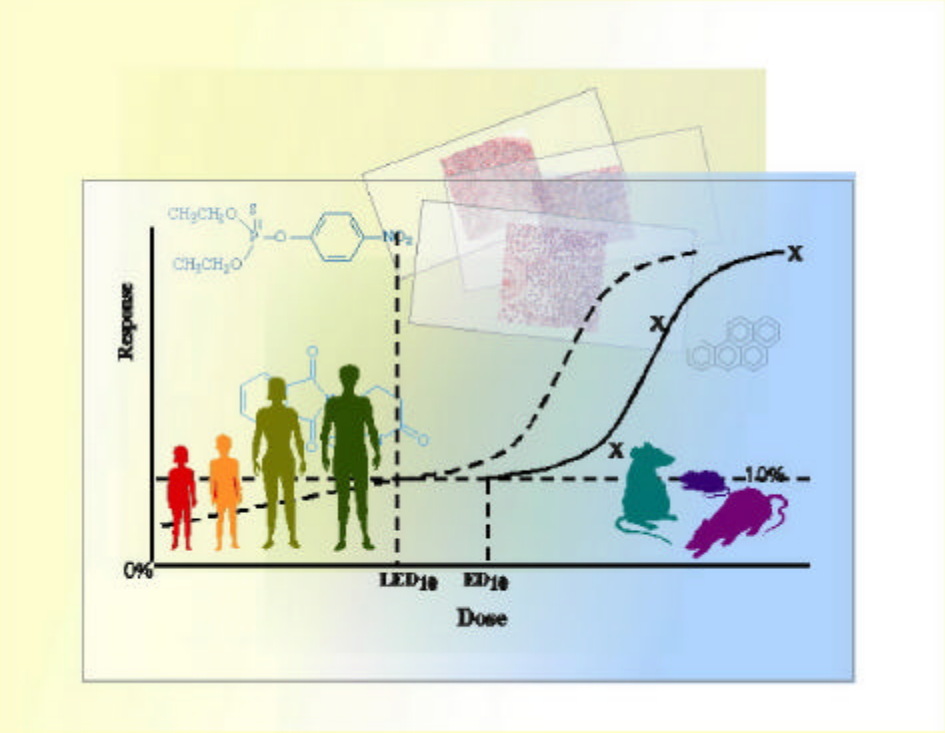
HUMAN HEALTH RISK ASSESSMENT

ACEPHATE



U.S. Environmental Protection Agency
Office of Pesticide Programs
Health Effects Division (7509C)

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HUMAN HEALTH RISK ASSESSMENT

ACEPHATE

Phase 4

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ACEPHATE REVISED RISK ASSESSMENT

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1. Executive Summary

Introduction

The Health Effects Division (HED) has conducted a human health risk assessment for the active ingredient **acephate** for the purpose of making a reregistration eligibility decision.

Acephate (O,S-dimethyl acetylphosphoramidothioate) is a systemic/contact organophosphate insecticide used for control of insects on a variety of field, fruit, and vegetable crops. Products containing acephate are intended for both occupational and residential uses. The residential uses of acephate include both indoor and outdoor applications.

HED evaluated the toxicology, residue chemistry, and occupational exposure databases for acephate and determined that the data are adequate to support a reregistration eligibility decision. This is an unusual assessment because acephate metabolizes to methamidophos, which is also a registered pesticide. This assessment will take into account risk from acephate and methamidophos from application of acephate. For dietary purposes, acephate and methamidophos from acephate application only were each assessed separately. In addition, an aggregate dietary risk assessment was conducted based on exposure from methamidophos from the application of acephate and of methamidophos. The occupational and non-occupational risk assessments were conducted for only acephate when assessing exposure to mixer/loaders/applicators (occupational and residential handlers). However, since acephate degrades to methamidophos, all post-application assessments (occupational, residential and recreational) were conducted for both acephate and methamidophos.

Acephate is an organophosphate. As with other chemicals in its class, cholinesterase inhibition is the major toxic effect of acephate; however, other toxic effects were also observed in the toxicology studies.

Toxicity Assessment

Acephate has low acute dermal and inhalation toxicity. It is non-irritating to skin, minimally irritating to the eyes and is not a skin sensitizer. It is classified under Category III for acute oral toxicity. Acephate is degraded to methamidophos in the environment.

Toxicity endpoints were selected based on cholinesterase (ChE) inhibition of the red blood cell, brain and plasma. Based on the developmental and reproductive toxicity studies reviewed, there does not appear to be any special sensitivity for pre- or post-natal effects in animals that were exposed to acephate *in utero*. Therefore the HED's FQPA Safety Committee determined that for acephate the 10-fold safety factor for the protection of infants and children be reduced to 1X. The specific doses and endpoints

selected by the HED Hazard Identification Assessment Review Committee for risk assessment were:

- ❏ Acute dietary - NOAEL = 0.5 mg/kg/day based on plasma and brain cholinesterase inhibition in an acute neurotoxicity range finding study in rats at 2.5 mg/kg/day.

- ❏ Chronic dietary - NOAEL = 0.12 mg/kg/day based on brain cholinesterase inhibition at 0.21 mg/kg/day from a 13 week toxicity study on rats. Although there is slight inhibition at 0.12 mg/kg, the inhibiton was considered minimal.

- ❏ Short-term and intermediate-term dermal - NOAEL = 12 mg/kg/day based on brain cholinesterase inhibition at 60 mg/kg/day from a 21-day dermal study.

- ❏ Short-term and intermediate-term inhalation - NOAEL = 0.0005 mg/L based on a plasma, brain and erythrocyte cholinesterase inhibition at >0.0005 mg/L from a 4 week inhalation study in rats.

All doses for risk assessment purposes were assessed uncertainty factors of 10x for interspecies extrapolation and 10x for intraspecies variability.

The acephate dietary risk assessments reflect highly refined exposure assessments; anticipated residues and percent crop-treated information were incorporated. Refinements were conducted in anticipation of a cumulative risk assessment being conducted in the future and also to permit a more realistic comparison of Drinking Water Levels of Comparison (DWLOC) with estimates of potential drinking water concentrations provided by the Environmental Fate and Effects Division (EFED). Acute dietary assessments were conducted using a probabilistic/Monte Carlo method with an acute population adjusted dose (aPAD) of 0.005 and 0.001 mg/kg/day for acephate and methamidophos, respectively; acute risk from acephate and methamidophos from application of acephate only resulted in 22% and 61% of the acephate and methamidophos aPAD consumed for the general U.S. population. The most highly exposed subpopulation, children (1 to 6 years) consumed 33% of the acephate aPAD. For methamidophos, the most highly exposed subpopulation was infants where 80% of methamidophos aPAD was consumed**.** Chronic risks calculated using chronic PADs (cPAD) of 0.0012 mg/kg/day (acephate) and 0.0001 mg/kg/day (methamidophos) were low. Chronic dietary risk resulted in 7% and 17% of the cPAD consumed for the general U.S. population and children (1 to 6 years old, again the most highly exposed subgroup), respectively for acephate. Methamidophos risks were also low with 16% and 19% of the methamidophos cPAD consumed for the general U.S. population and children (1 to 6 years old, also the most highly exposed subgroup).

Aggregate Exposure Assessment

In examining aggregate exposure, EPA takes into account the available and reliable information concerning exposures from pesticide residues in food and other exposures include drinking water and non-occupational exposures, e.g., exposure to pesticides used in and around the home. Risk assessments for aggregate exposure consider both short-, intermediate- and long-term (chronic) exposure scenarios considering the toxic effects which would likely be seen for each exposure duration.

There are residential uses of acephate; therefore, the considerations for aggregate exposure are those from food, water, and residential uses. Additionally, since methamidophos is a metabolite of acephate, aggregate risk assessments determining the methamidophos risks from application of both acephate and methamidophos, and from applications of acephate alone were conducted.

Aggregate Risk - Chronic Exposures (Food Only)

For chronic aggregate risk (food only), chronic exposures to methamidophos from application of acephate and application of methamidophos were combined and compared to the methamidophos PAD. This assessment was conducted using anticipated residues and BEAD percent crop-treated information. Results of the chronic exposure analysis show that 23% of the cPAD is consumed for the U.S. population. The most significantly exposed subpopulation, children (1 to 6 years) occupied 37% of the cPAD, respectively. The results indicate that HED has no concern for chronic aggregate exposure from food alone.

Aggregate Risk - Acute Exposures (Food Only)

An acute aggregate dietary exposure analysis (food only) that considers methamidophos from application of acephate and of methamidophos was also conducted. For this analysis residue refinements including anticipated residues generated from field trial and monitoring data, adjustments for percent crop treated, washing and cooking factors, and a probabilistic/Monte Carlo acute analysis were utilized. Applying all of these refinements, the most highly exposed population subgroup was children 1-6 years with a %aPAD of 120%. For the general U.S. population, 79% of the aPAD was consumed. The results indicate that for children, 100% of the aPAD is exceeded.

Exposures From Drinking Water

With respect to the exposure in water, conservative Tier II (PRZM-EXAMS) modeling was provided by EFED and indicate that acephate concentrations in surface water are not likely to exceed 82 ppb for peak (acute) exposure and 15 ppb for mean (chronic) exposure. Surface water Estimated Exposure Concentrations (EECs) for drinking water exposure estimates for methamidophos were generated using GENEEC modeling (Tier I) assuming a 25% conversion efficiency. A Tier II assessment using PRZM-EXAMS

was not conducted because of the high uncertainty surrounding any estimate of the decay rate for acephate and the transformation rate of acephate to methamidophos needed for the PRZM simulation. The EECs for methamidophos formed as a degradate from acephate used on cotton were 22 ppb for peak (acute) and 12 ppb for mean (chronic) exposure. Using the SCI-GROW model to estimate concentrations of methamidophos in ground water, yielded low EECs for both acute and chronic exposure of acephate and methamidophos at 0.02 and 0.005 μg/L, respectively.

Upon comparison of the chronic Drinking Water Levels of Comparison (DWLOCs) with the environmental concentrations of acephate, surface water concentrations exceed the DWLOCs for infants and children. Consequently, there appears to be a potential for acephate residues in surface water to occur at levels of concern for infants and children. For methamidophos, EECs for surface water are greater than the DWLOCs for all subpopulations; therefore, there may also be chronic dietary concern for methamidophos residues in drinking water.

Acute surface water concentrations exceed the acute DWLOCs for acephate (infants and children) and for methamidophos (all subpopulations). Thus, there appears to be a potential for acephate and methamidophos residues in surface water to occur at levels of concern. Drinking water monitoring data would allow refinement of the estimated environmental concentrations (EECs).

There are no chronic or acute concerns for drinking water from groundwater sources.

An aggregate exposure assessment which considers risk from food (from application of acephate and application of methamidophos) and water was conducted for chronic exposure only since HED has concerns for acute aggregate exposure from food alone. Using the aggregate chronic food exposure (exposure which incorporates methamidophos residues from application of both methamidophos and acephate), DWLOCs were calculated. The results indicate that there may be concern for children(1 to 6 years) and infants.

An aggregate exposure assessment that quantifies risk from food, water, and residential sources was not conducted because HED has concern regarding risks from residential exposure alone.

Occupational Exposure and Risk Assessment

Occupational and non-occupational (residential and recreational) exposure assessments were conducted for acephate. In addition to quantifying risk to acephate exposures, all post-application assessments (occupational, residential and recreational) addressed methamidophos exposures and risks due to the application of acephate products.

For occupational risk analysis, more than twenty-five exposure handler scenarios were identified for acephate. Only two chemical-specific exposure monitoring studies were

submitted in support of the reregistration of acephate. The majority of analyses for both short- and intermediate-term exposures were performed using the Pesticide Handlers Exposure Database (PHED), Version 1.1 (August 1998).

The calculations of handler's combined dermal and inhalation risks indicate that at the highest level of mitigation available and/or feasible for a specific scenario, thirteen of the scenarios do not exceed 100. There are also five scenarios for which no exposure data are available and four scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the handler/applicators' scenarios was 0.065 to 28,000.

The Agency has determined that workers may be exposed to acephate and methamidophos upon entering occupational areas which have been previously treated with acephate to perform specific work activities in these areas (e.g., scouting, staking/tieing, irrigating, harvesting). Due to the frequency and duration of post-application worker exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses result in potential intermediate-term dermal acephate and methamidophos post-application worker exposures. Potential inhalation exposures are not anticipated for post-application worker exposures, and the Agency currently has no policy/method for evaluating non-dietary ingestion by workers due to poor hygiene practices or smoking. As a result, only dermal exposures were evaluated in the post-application worker assessment. Valent submitted four dislodgeable foliar residue studies (DFRs) and one turf transferable residue study (TTR) which address the dissipation of acephate and methamidophos in fields/greenhouses of succulent beans, cauliflower, greenhouse roses, tobacco, and turfgrass. These studies were used to evaluate potential post-application worker risks.

Re-entry intervals (REIs) were calculated for specific tasks. Calculated REIs for succulent beans while performing harvest by hand, stake/tie, scout, and irrigate were 5 days. Calculated REIs for cauliflower while performing scout, irrigate, and harvest by hand were 0 days. Calculated REIs for greenhouse roses while sorting and packing was 6 days and while pruning and harvesting by hand was 12 days. Calculated REIs for tobacco while performing stake/tie, scout and irrigate was 8 days and while harvesting by hand was 19 days. Calculated REIs for turfgrass while mowing with tractor or push-type mower was 0 days and while harvesting sod was 1 day. It should be noted that the default REI of 24 hours will still apply to cauliflower and turf under the Worker Protection Standard.

Non-Occupational Exposure and Risk Assessment

Residential acephate applications can be carried out by several methods that include aerosol can, shaker can, backpack sprayer, hand/handtool/shaker can, hose-end sprayer, low-pressure handwand, and sprinkler can. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by residential pesticide/handlers applicators result in short-term exposures to these applicators. The calculated combined dermal and inhalation risks indicate that two exposure scenarios exceed 100 while six scenarios do not. There are also two scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the residential acephate applicators' scenarios was 2.9 to 7,100.

The public may be exposed to acephate and methamidophos upon entering residential areas that have been previously treated with acephate. The available data indicated that residential acephate uses result in potential short-term dermal and oral acephate and methamidophos post-application residential exposures to the public. However, inhalation exposures are not anticipated for post-application residential exposures.

It is anticipated that adults and children may primarily be exposed to acephate and methamidophos through their contact with turfgrass. The analyses indicated that the following acephate post-application residential exposure scenarios exceed the Agency's level of concern: dermal exposures to children (MOE = 86) and children's hand-to-mouth exposures (MOE = 94). None of the methamidophos post-application residential exposure scenarios exceed the Agency's level of concern (MOE range = 1,500 - 500,000). It should be noted that the residential SOPs specify that the residential exposure calculations are to be used as screening tools.

The public may also be exposed to acephate and methamidophos upon entering recreational areas that have been previously treated with acephate. The recreational areas addressed in this assessment are golf courses. The potential post-application exposures are short-term dermal exposures. Inhalation exposure is not anticipated.

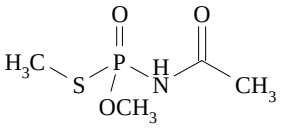
The calculated MOEs for adult golfers' risks to acephate and methamidophos were 7,500 and 125,000, respectively, while the calculated MOEs for 13+ year-old golfers' risks to acephate and methamidophos were 4,620 and 78,100, respectively.

Data Needed to Further Refine Risk Estimations

Several areas of the risk assessment and characterization would improve with more data. Chemical-specific exposure studies for occupational and non-occupational (residential and recreational) exposures could refine the risk assessment. In particular, data characterizing applicator scenarios for which no data are currently available to the Agency would improve the assessment. Additionally, specific data on typical use, types of mixing and loading completed for application equipment, types of packaging available to individual and professional pesticide applicators, types of potential engineering controls, additional information on slit-placement techniques for turf applications of granules, and information on post-application techniques for all crops could also improve the assessment.

2. Physical/Chemical Properties Characterization

ACEPHATE



Empirical Formula: $C_4H_{10}NO_3PS$
Molecular Weight:183.16
CAS Registry No.:30560-19-1
Shaughnessy No.:103301

Acephate is a colorless to white solid with a melting point of 81-91 C. Acephate is highly soluble in water (79.0 g/100 mL), acetone (151 g/100 mL), and ethanol (>100 g/100 mL), and is soluble in methanol (57.5 g/100 mL), ethyl acetate (35.0 g/100 mL), benzene (16.0 g/100 mL), and hexane (<0.1 g/100 mL) at 25 C.

A search of the Reference Files System (REFS) conducted 1/29/97 identified four acephate manufacturing-use products (MPs) registered under Shaughnessy No. 103301. The registered acephate MPs are listed in Table 1; only these products are subject to a reregistration eligibility decision.

Table 1. Registered Manufacturing-use Products of Acephate

Formulation	EPA Reg. No.	Registrant
97% T	51036-246	Micro-Flo Company
97% T	59639-41	Valent U.S.A. Corporation
Orthene MFG	59639-42	

3. Hazard Characterization

The toxicological database for acephate is adequate to support reregistration. In general the dominant toxic effects seen in various toxicity studies were the effects generally associated with cholinesterase inhibition. Although the rat metabolism studies submitted were found to be inadequate, these studies are summarized in this hazard assessment. While the lack of an adequate metabolism study will not affect the Reregistration Eligibility for acephate, a new confirmatory rat metabolism study is required. The available toxicology studies are summarized in this hazard assessment. Tables 2, 3a, and 3b present the acute toxicity profile for acephate and the HIARC toxicity endpoints and doses for risk assessment, respectively.

3.1 Hazard Profile

Acephate has low acute dermal and inhalation toxicity (Tox. Category IV). It is non-irritating to skin and eyes and is not a skin sensitizer. It is classified under Category III for acute oral toxicity (see Table 2.)

Sufficient data are available to describe the subchronic toxicity of acephate. In a special oral cholinesterase inhibition study, acephate had no effect on body weights and no toxic signs were observed. Tissue abnormalities were not observed at necropsy and there was no mortality. There was inhibition of plasma, RBC, brain cholinesterase (ChE) down to 0.12 mg/kg BW/day. With dermal application, cholinesterase inhibition occurred in a dose-related manner, was significant, and was seen in the brain. Two inhalation studies were also submitted. In the high dose study, tremors, miosis, decreased body weight and weight gain, and histopathological findings as well as plasma, brain and erythrocyte ChE inhibition were seen. No treatment-related changes in body weight, food consumption, clinical chemistry or hematology parameters, plasma, erythrocyte or brain cholinesterase activity, or histopathology findings were seen in the other study conducted at lower dose rates.

Adequate data are available to assess the chronic toxicity and carcinogenic potential of acephate. The most consistent toxicological findings following chronic acephate exposure were decreased body weight gain (rats) and inhibition of plasma, erythrocyte and/or brain cholinesterase (rats and dogs). Other treatment related effects (decreased hematological parameters, increased thromboplastin time, increased absolute liver weight, and histological changes in the liver) were seen in the dog at the high dose (167 mg/kg/day). Acephate has been classified as a Group C, possible human carcinogen; however, it was concluded that no quantitative risk assessment is needed based on the occurrence of tumors, mainly carcinomas in only one sex of one species, and only at the highest dose; and the lack of mutagenicity seen in *in vivo* mutagenicity studies.

Two developmental toxicity studies (rat and rabbit) and one reproductive toxicity study in rats were available for review. These data are considered adequate to assess the developmental and reproductive toxicity potential of acephate, no significant developmental and reproductive toxic effects were found. There is no indication of an increased sensitivity of the offspring of rats or rabbits to pre-natal or postnatal exposure to acephate. In all studies examined, maternal or parental NOAELs are lower or equivalent to the offspring NOAELs.

Fourteen acceptable mutagenicity studies were submitted. The results from the *in vitro* studies indicated that acephate was mutagenic in bacteria, yeast and cultured mammalian cells. Acephate also caused recombination and gene conversion in yeast, SCE in a cultured mammalian cell line and UDS in human fibroblasts. In general, genotoxicity was limited to high concentrations and exogenous metabolic activation (S9 microsomal fraction) was not required to cause the positive responses. Attempts to characterize the mutagenic component(s) of acephate by investigating a series of acephate samples of varying purities in the Ames test failed; mutagenicity in these studies did not decrease with increasing purity levels of the test material. Nevertheless, the data from the *in vivo* assays with acephate clearly showed that the genotoxic activity of acephate was not expressed in whole animals. The Hazard Identification Assessment Review Committee (HIARC) concluded, therefore, that the negative findings from the *in vivo* studies lessen the concern for a potential mutagenic hazard.

Two metabolism studies submitted were found to be inadequate although some information was provided to gain some understanding of the metabolism of acephate by the rat. The results show that acephate is rapidly and completely absorbed from the stomach and rapidly excreted in urine. About 87% and 95% of the administered radioactivity (^{14}C) was excreted, respectively, during the first 6 and 12 hours after dosing. Most of the remaining ^{14}C was found in the exhaled air, feces and tissues. The ^{14}C found in urine was unchanged acephate (73-77%), DMPT (O,S-dimethyl phosphorothioate; 3-6%) and S-Methyl acetylphosphoramidothioate; (3-4%). Methamidophos was not detected in urine, and it was concluded that methamidophos was only a plant and soil metabolite of acephate. Of the 0.4% ^{14}C recovered in tissues, most (0.13-0.26%) was in the liver and least (0.001-0.004%) in the brain. Male and female rats had the same excretion pattern.

In another rat metabolism study, the purpose was to investigate whether methamidophos was formed from acephate in rats. Results indicated that acephate was rapidly absorbed and eliminated by the rats. There was no tendency for acephate to concentrate in blood, liver, muscle, fat, heart and brain. The rat converted a portion of acephate to methamidophos. Evidence was presented that the conversion took place in the small intestine and, to a lesser extent, in the stomach, and was apparently effected by the microorganisms. Methamidophos was then absorbed from the stomach and intestines, and distributed throughout the body. There was also no indication for methamidophos to accumulate in blood, liver, muscle, fat and heart.

Acceptable acute and subchronic delayed neurotoxicity studies in hens and acute and subchronic neurotoxicity screening batteries in rats were available for review. There were no data gaps for the assessment of the neurotoxic potential of acephate. Data from the hen studies indicate that acephate produces toxic signs characteristic of ChE inhibition (acute and subchronic exposures), but no delayed neurotoxicity or histological changes in brain, spinal cord or peripheral nerves. In an acute neurotoxicity study in rats, neurotoxic effects were seen at the lowest dose tested (whole body tremors, decreased rotarod performance) as well as plasma, RBC, and brain cholinesterase inhibition. In a subchronic neurotoxicity study in the rat, the most prevalent effect was cholinesterase inhibition.

The toxicity of methamidophos, a metabolite of acephate is discussed in the HED chapter of the methamidophos Human Health Assessment. However, since the risk assessment for methamidophos resulting from applications of acephate is discussed in this document, methamidophos risk assessment endpoints and NOAELs are provided in Table 3b.

Table 2A. Toxicity Profile of Acephate

Guideline No.	Study Type	MRID #	Results	Tox. Category	Study Classification
Acute Toxicity					
81-1	Acute Oral LD_{50} (rat)	00014675	945 mg/kg ♂ 866 mg/kg ♀		
81-1	Acute Oral LD_{50} (rat) Recalculation	00029686	1.4 g/kg ♂ 1.0 g/kg ♀	3	Acceptable
81-2	Acute Dermal LD50 (rabbit)	00055602	>10 g/kg ♂	4	Acceptable
81-3	Acute Inhalation LC_{50} (rat)	00015307	>61.7mg/L	4	Acceptable
81-4	Primary Eye Irritation (Rabbit)	00014686	Non-irritant	4	Acceptable
81-5	Primary Dermal Irritation (Rabbit)	00015305	PIS = 0.1 (Intact and abraded skin)	4	Acceptable
81-6	Dermal Sensitization (Guinea pig)	00119085	Negative	---	Acceptable

Table 2B.

Guideline No.	Study Type	MRID #	Results	Core Grade
Subchronic Toxicity				
82-1(a) 870.3100	90-day feeding-rat (Special ChE inhibition study)	40504819	ChE NOAEL(plasma) = 0.76 mg/kg/day ♀, 0.58 mg/kg/day ♂ ChE LOAEL(plasma) = 11.48 mg/kg/day ♀, 8.9 mg/kg/day ♂ ChE NOAEL (brain) = <0.15 mg/kg/day ♀, <0.12 mg/kg/day ♂ ChE LOAEL (brain) = 0.15 mg/kg/day ♀ (LDT), 0.21 mg/kg/day ♂ ChE NOAEL (RBC) = 0.76 mg/kg/day ♀, 0.58 mg/kg/day ♂ ChE LOAEL (RBC) = 11.48 mg/kg/day ♀, 8.9 mg/kg/day ♂	Acceptable
82-2 870-3200	21-day dermal-rat	44541101	NOAEL =12 mg/kg/day LOAEL = 60 mg/kg/day based on reduced brain ChE No dermal toxicity was seen.	Acceptable

Guideline No.	Study Type	MRID #	Results	Core Grade
82-3 870-3465	4-week inhalation-rat	40504818	systemic NOAEL = 0.0108 mg/L systemic LOAEL =0.0936 mg/L based on tremors, miosis, decreased body weight and weight gain, and histopathological changes in the nasal cavity. ChE NOAEL(plasma) = 0.00105 mg/L ChE LOAEL(plasma) = 0.0108 mg/L ChE NOAEL (brain and erythrocyte) = <0.00105 mg/L (LDT) ChE LOAEL (brain and erythrocyte) = 0.00105 mg/L	Acceptable
82-3 870-3465	4-week inhalation-rat	40645903	systemic NOAEL = 0.0005 mg/L HDT) ChE NOAEL (plasma, erythrocytes, and brain) =0.0005 mg/L ChE LOAEL= >0.0005mg/L (HDT)	Acceptable
Chronic Toxicity				
83-1(a)	1-year chronic feeding/carcinogenicity study in rats	00084017 00101623	systemic NOAEL = 2.5 mg/kg/day ♂ ; >35 mg/kg/day ♀ systemic LOAEL = 35 mg/kg/day based on neurotoxic signs, decreased body weight gain and food efficiency ChE (plasma, RBC, and brain) NOAEL=0.25 mg/kg/day ChE (plasma, RBC, and brain) LOAEL = 2.5 mg/kg/day	Acceptable
83-1(b) 870-4100	1-year chronic feeding-dog	41812001	systemic NOAEL = 3.11 mg/kg/day systemic LOAEL = 20.16 mg/kg/day (HDT) based on decreases in hematological parameters, increase in thromboplastin time, increase in absolute liver weight and histological changes in the liver ChE NOAEL(plasma) = 20.16 mg/kg/day ChE LOAEL(plasma) = >20.16 mg/kg/day ChE NOAEL (brain) = <0.27 mg/kg/day ♀, 0.27 mg/kg/day ♂ ChE LOAEL (brain) = 0.27 mg/kg/day ♀(LDT), 3.11 mg/kg/day ♂ (LDT) ChE NOAEL (RBC) = 0.27 mg/kg/day ChE LOAEL(RBC) = 3.11 mg/kg/day	Acceptable
83-5 870.4300	Chronic feeding/ Carcinogenicity-rats	008417	No treatment related increases in tumor incidence	Acceptable

Guideline No.	Study Type	MRID #	Results	Core Grade
83-2(b)	Carcinogenicity-mouse	00105197, 00077209, 00105198, 00129156	systemic NOAEL =7 mg/kg/day ♂, 8 mg/kg/day ♀ systemic LOAEL =36 mg/kg/day ♂, 42 mg/kg/day ♀ based on body weight gains, decreased(in males) or increased (in females) weights of livers, decreased weights of kidneys, and non-neoplastic lesions in liver and lungs At 167 mg/kg/day (HDT) ♂, increased incidence of heptocellular carcinomas in female mice was found	Acceptable
Developmental/Reproductive Toxicity				
83-3(a)	Developmental toxicity study-rat	41081602	Maternal Toxicity NOAEL = 5 mg/kg/day LOAEL =20 mg/kg/day based on reduced body weights, body weight gains, food consumption, and food efficiency Developmental Toxicity NOAEL = 20 mg/kg/day LOAEL = 75 mg/kg/day based on decreases in mean numbers of ossification centers per litter	Acceptable
83-3(b)	Developmental toxicity study-rabbit	00069684 00069683	Maternal Toxicity NOAEL = 3 mg/kg/day LOAEL = 10 mg/kg/day (HDT) based on increased abortions Developmental Toxicity NOAEL = >10 mg/kg/day (HDT)	Acceptable
83-4	Multi-generation Reproduction study-rats	40323401 40605701	Parental Toxicity NOAEL =2.5 mg/kg/day LOAEL =25 mg/kg/day based on decreased body weights and/or weight gains Reproductive Toxicity NOAEL =2.5 mg/kg/day LOAEL =25 mg/kg/day based on decreased viability index (two generations and mating performance (one generation)	Acceptable

Guideline No.	Study Type	MRID #	Results	Core Grade
			Neurotoxicity	
81-7	Acute delayed neurotoxicity in hens	00154884	No delayed neurotoxicity was found in the treated hens. However, cholinergic and neurotoxic effects occurred shortly after dosing and disappeared within 10 days. No lesions were observed in the sciatic nerve which included diarrhea, lethargy, limb weakness, and loss of coordination.	Acceptable
	Acute range finding neurotoxicity in rats	44203301	Systemic toxicity NOAEL = 5 mg/kg LOAEL = 25 mg/kg based on clinical signs such as lacrimation altered gait, and constricted pupils Plasma ChE NOAEL = 0.5 mg/kg ♂ and <5 mg/kg ♀ LOAEL = 2.5 mg/kg♂ and 5 mg/kg ♀ RBC ChE NOAEL = 2.5 mg/kg ♂ and <5 mg/kg ♀ LOAEL = 5 mg/kg (both sexes) Brain ChE NOAEL = 0.5 mg/kg ♂ and <5 mg/kg ♀ LOAEL = 2.5 mg/kg♂ and <5 mg/kg ♀	Acceptable
81-8	Acute neurotoxicity - rats	44203303	Neurotoxicity NOAEL = <10 mg/kg LOAEL = 10 mg/kg (LDT) based on whole body tremors, decreased rotarod performance ChE NOAEL = <10 mg/kg ChE LOAEL = 10 mg/kg based on plasma, RBC, and brain ChE inhibition	Acceptable

Guideline No.	Study Type	MRID #	Results	Core Grade
82-7	Subchronic neurotoxicity - rats	44203304	Systemic toxicity NOAEL = 0.33 mg/kg/day♀ and 0.41 mg/kg/day ♂ LOAEL = 49 mg/kg/day ♀ and 58.27 mg/kg/day ♂ based on increases in clinical signs Neurotoxicity NOAEL = 3.95 mg/kg/day♀ and 3.31 mg/kg/day ♂ LOAEL =58.3 mg/kg/day ♀ and 48.6 mg/kg/day♂ based on decreased rotarod time, and increased rearing. Erythrocyte ChE NOAEL = 3.31 mg/kg ♂ and 3.95 mg/kg♀ ChE LOAEL = 48.6 mg/kg♂ and 58.3 mg/kg ♀ Plasma ChE NOAEL = 0.41 mg/kg/day♀ and 0.33 mg/kg/day ♂ ChE LOAEL =3.31 mg/kg ♂ and 3.95 mg/kg♀ Brain ChE NOAEL = <0.33 mg/kg ♂ and <0.41 mg/kg ♀ ChE LOAEL = 0.33 mg/kg♂ and 0.41 mg/kg ♀	Acceptable
Mutagenicity				
84-2 **870.5100** **870.5375** **870.5550**	Mutagenicity studies	00119080, 00028625, 00132948, 00132947, 000132949, 00132950, 00137738, 40209101, 00132953, 00119081, 00132955, 00132949, 00132954, 00028625	Fourteen acceptable mutagenicity studies were submitted. The results from the *in vitro* studies indicated that acephate was mutagenic in bacteria, yeast and cultured mammalian cells. Acephate also caused recombination and gene conversion in yeast, SCE in a cultured mammalian cell line and UDS in human fibroblasts. In general, genotoxicity was limited to high concentrations and exogenous metabolic activation (S9 microsomal fraction) was not required to uncover the positive responses. Attempts to characterize the mutagenic component(s) of acephate by investigating a series of acephate samples of varying purities in the Ames test failed; mutagenicity in these studies did not decrease with increasing purity levels of the test material. Nevertheless, the data from the *in vivo* assays with acephate clearly showed that the genotoxic activity of acephate was not expressed in whole animals. Confidence in the negative findings, particularly for the mouse somatic cell and the dominant lethal assays, is high because of the response induced in the target organ.	Acceptable

Guideline No.	Study Type	MRID #	Results	Core Grade
Metabolism				
85-1	Metabolism study- rats	00014994	Acephate is rapidly and completely absorbed from the stomach and rapidly excreted in urine. Methamidophos was not detected in urine, and the author concluded that Methamidophos was only a plant and soil metabolite of acephate.	Acceptable
85-1	Metabolism study-rats	00014219	Acephate was rapidly absorbed and rapidly eliminated by the rats. There was no tendency for acephate to concentrate in blood, liver, muscle, fat, heart and brain. Rats converted a portion of acephate to methamidophos. Evidence was presented that the conversion took place in the small intestine and, to a lesser extent, in the stomach, and was apparently effected by the microorganisms. There was no tendency for methamidophos to accumulate in blood, liver, muscle, fat and heart.	Acceptable

NOAEL = No Observable Adverse Effect Level
LOAEL = Lowest Observable Adverse Effect Level
LDT = Lowest Dose Tested; HDT = Highest Dose Tested
ChE = Cholinesterase

3.2 Dose Response Assessment

The strengths and weaknesses of the acephate toxicology database were considered during the process of toxicity endpoint and dose selection. In general, all the required guideline studies on acephate were available and provided reasonable confidence when the toxicity endpoints and doses for risk assessment were selected. Based on the evaluation of the above summarized studies, the Hazard Identification Assessment Review Committee identified the toxicity endpoints and the dose levels for use in risk assessments (HIARC document of 1/15/98). These endpoints are summarized in Table 3a (acephate) and 3b (methamidophos).

Table 3a. Acephate Endpoints Used For Risk Assessment

Exposure Scenario	NOAEL for use in Risk Assessment	Uncertainty Factor	Endpoint
Acute Dietary	0.5 mg/kg/day (acute neurotoxicity range finding study) aRfD = 0.005 mg/kg/day aPAD = 0.005 mg/kg/day	100	Brain and plasma ChE inhibition
Chronic Dietary	0.12 mg/kg/day (90-day feeding study) cRfD = 0.0012 mg/kg/day cPAD = 0.0012 mg/kg/day	100	Brain ChE inhibition
Short-Term (1-7 days)	12 mg/kg/day (21-day dermal toxicity study)	100	Brain ChE inhibition
Intermediate-Term Exposure (1 week to several months)	12 mg/kg/day (21-day dermal toxicity study)	100	Brain ChE inhibition
Long-Term Exposure (several months to lifetime)	Not applicable The use pattern does not indicate potential long-term dermal or inhalation exposure.	N/A	N/A
Inhalation Exposure (any duration)	0.0005 mg/kg/day (4 week Inhalation Toxicity Study)	100	Brain ChE inhibition
Carcinogenic	Acephate has been classified as a Group C, possible human carcinogen. Quantitative cancer risk assessment is not required.	N/A	N/A
Aggregate Assessment	The dermal and inhalation MOES may be combined to obtain a total MOE since a common toxicological endpoint (cholinesterase inhibition) was observed.	N/A	N/A
FQPA Considerations	For acephate the 10-fold uncertainty factor to account for the protection of infants and children has been removed. An uncertainty factor of 100 to account for interspecies extrapolation and intraspecies variability will be used. Thus, for all scenarios, MOEs equal to or greater than 100 are not of concern.	N/A	N/A

NOAEL - No Observable Adverse Effect Level, ChE = Cholinesterase, MOE = Margins of Exposure, N/A = not applicable

Note that long-term exposure/risk assessments are not evaluated in this document. Since the exposures that would result from the uses of acephate were determined to be of an intermittent nature (i.e., the frequency and duration of these exposures do not exhibit a chronic exposure pattern), neither a long-term assessment nor a carcinogenic assessment are appropriate.

Table 3b. Methamidophos Endpoints Used For Risk Assessment

Exposure Scenario	NOAEL for use in Risk Assessment (Study)	Uncertainty Factor	Endpoint
Acute Dietary	0.3 mg/kg/day (Acute Neurotoxicity-rat) ARfD = 0.003 mg/kg/day aPAD = 0.001 mg/kg/day	300*	Plasma, erythrocyte and brain ChE inhibition
Chronic Dietary Adjusted RfD = 0.0001 mg/kg/day	0.03 mg/kg/day (8 week toxicity-rat) cRfD = 0.0003 mg/kg/day cPAD = 0.0001 mg/kg/day	300*	Brain ChE inhibition
Short-Term (1-7 days)	0.75 mg/kg/day (21 day dermal-rat)	100	Brain ChE inhibition
Intermediate-Term Exposure (1 week to several months)	0.75 mg/kg/day (21-day dermal-rat)	100	Brain ChE inhibition
Long-Term Exposure (several months to lifetime)	Not applicable The use pattern does not indicate potential long-term dermal or inhalation exposure.	N/A	N/A
Inhalation Exposure (any duration)	0.001 mg/L (90-day inhalation- rat)	100	plasma, brain and erythrocyte ChE inhibition
Carcinogenic	Methamidophos has been classified as a "not likely" human carcinogen. Risk assessment not required.	N/A	N/A
Aggregate Assessment	The dermal and inhalation MOE's may be combined to obtain a total MOE since a common toxicological endpoint (cholinesterase inhibition) was observed.	N/A	N/A
FQPA Considerations	For methamidophos the 10-fold uncertainty factor to account for the protection of infants and children has been reduced to 3X. Thus, for all scenarios, MOEs equal to or greater than 300 are not of concern.	N/A	N/A

NOAEL - No Observable Adverse Effect Level, ChE = Cholinesterase, MOE = Margin of Exposure, N/A = not applicable

Note that long-term exposure/risk assessments are not evaluated in this document. Exposures from the uses of methamidophos were determined to be of an intermittent nature (i.e., the frequency and duration of these exposures do not exhibit a chronic exposure pattern); therefore long-term assessment is not required.

*The 300x safety factor which includes a 3X factor for FQPA, is applicable for dietary exposures and residential exposures to methamidophos which occur as a result of acephate application.

3.3 Determination of Safety for Infants and Children

FFDCA section 408 provides that EPA shall apply an additional tenfold margin of safety for infants and children in the case of threshold effects to account for pre-and post-natal toxicity and the completeness of the database unless EPA determines that a different margin of safety will be safe for infants and children. Margins of safety are incorporated into EPA risk assessments either directly through use of a MOE analysis or through using uncertainty (safety) factors in calculating a dose level that poses no appreciable risk to humans.

Uncertainty factor: The Agency determined that for acephate the 10-fold uncertainty factor for the protection of infants and children would be removed. This conclusion was based upon the following:

(a) In prenatal developmental toxicity studies following *in utero* exposure in rats and rabbits, there was no evidence of effects being produced in fetuses at lower doses as compared to maternal animals nor was there evidence of an increase in severity of effects at or below maternally toxic doses.

(b) In the pre/post natal two-generation reproduction study in rats, there was no evidence of enhanced susceptibility in pups when compared to adults (i.e., effects noted in offspring occurred at maternally toxic doses or higher).

(c) There was no evidence of abnormalities in the development of the fetal nervous system in the pre/post natal studies.

(d) There was no convincing evidence for requiring a developmental neurotoxicity study in rats.

(e) The toxicology data base is complete and there are no data gaps according to Subdivision F Guideline requirements including meeting any of the triggers for requiring a developmental neurotoxicity study in rats.

4. Exposure Assessment

4.1 Summary of Registered Uses

Acephate is a systemic/contact organophosphate insecticide manufactured in the United States by Valent U.S.A. Corporation under the trade name Orthene®. Products containing acephate are intended for both occupational and residential uses. Acephate is currently registered for food/feed uses on a variety of field, and vegetable crops as well as on food-handling establishments for the control of insect pests. The granular (G) and soluble concentrate (SC) are the acephate formulation classes registered for use on these sites. These formulations are typically applied to food/feed crops as foliar, soil, and/or seed treatments using ground or aerial equipment and at food-handling establishments as spot or crack-and crevice treatments. Occupational uses include terrestrial food and feed crops, indoor food uses, terrestrial non-food crops, commercial/industrial, and golf course turf. There are residential uses of acephate which include both indoor and outdoor uses. An acephate Use Closure Memo dated December 23, 1997 was written which clarified acephate food uses that were used in this risk assessment. This memo lists the following maximum application rates for food crops treated with acephate:

- ❑ Beans (snap, dry, lima) 2 lb ai per acre per crop cycle
- ❑ Brussels sprouts 2 lb ai per acre per crop cycle
- ❑ Cauliflower 2 lb ai per acre per crop cycle
- ❑ Celery 2 lb ai per acre per crop cycle
- ❑ Cotton 6 lb ai per acre per crop cycle
- ❑ Cranberries 1 lb ai per acre per crop cycle
- ❑ Head Lettuce 2 lb ai per acre per crop cycle
- ❑ Peanut 4 lb ai per acre per crop cycle
- ❑ Pepper (non-bell) 1 lb ai per acre per crop cycle
- ❑ Pepper (bell) 2 lb ai per acre per crop cycle
- ❑ Peppermint/Spearmint 2 lb ai per acre per crop cycle
- ❑ Soybean 1.5 lb ai per acre per crop cycle
- ❑ Tobacco 4 lb ai per acre per crop cycle

4.2 Dietary Exposure

Potential dietary exposure to acephate residues in the diet occurs through food and water. Data supporting food exposure are adequate and are summarized in the Residue and Product Chemistry Chapters (Attachment 2). Exposure to acephate residues in ground and surface water was estimated using conservative modeling techniques; available monitoring data were assessed but were not considered adequate for quantitative risk assessment purposes.

4.2.1 Food Exposure

The chemistry database is essentially complete. Based on the available plant and animal metabolism data, the acephate residues of concern in plant commodities are those that are currently regulated, acephate and its cholinesterase- inhibiting metabolite, methamidophos. Since methamidophos is itself a registered pesticide, the Agency will initiate a change in the residue definition of acephate tolerances for plant commodities in order to eliminate redundancy. The Agency is now recommending that all acephate tolerances be expressed in terms of only acephate *per se* under 40 CFR §180.108. Residues of methamidophos resulting from the metabolism of acephate are more appropriately placed under the tolerance regulations for methamidophos as a pesticide [40 CFR §180.315.(c)]. A statement which informs the reader of these changes should be placed under both 40 CFR §180.108 and 40 CFR §180.315. Additionally, the registrant is advised to add a statement to the label which states that no methamidophos products should be applied after application of acephate since this may result in illegal residues.

Adequate methods are available for data collection and tolerance enforcement for plant and animal commodities. Pending label amendments for some crops, adequate field trial data are available to reassess the established tolerances for residues of acephate *per se* in/or on the following plant and animal commodities, as defined: beans (succulent and dry form); Brussels sprouts; cauliflower; celery; cottonseed; cranberries; lettuce (head); peanuts; peppers; and poultry. The available data suggest that the tolerance level for cottonseed can be lowered.

The available ruminant feeding data suggest that the established tolerances for residue of acephate per se in milk and the fat, meat, and meat byproducts of cattle, goats, hogs, and horses are adequate. However, actual reassessment of tolerances will be made when the requested residue data for all major livestock feed items have been submitted and following recalculation of maximum dietary burden.

Codex MRLs have been established for residues of acephate and methamidophos *per se*.

HED conducts dietary risk assessments using the Dietary Exposure Evaluation Model (DEEM^{TM}), which incorporates consumption data generated in USDA's Continuing Survey of Food Intakes by Individuals (CSFII), 1989-1992. For chronic dietary risk assessments, the three day average of consumption for each sub-population is combined with residues in commodities to determine average exposure in mg/kg/day. For acute dietary risk assessments, the entire distribution of

single day food consumption events is combined with either a single residue level (deterministic analysis) or a distribution of residues (probabilistic analysis, referred to as “Monte Carlo”) to obtain a distribution of exposure in mg/kg/day. For deterministic (Tier 1) analyses, the Agency regulates at the 95th percentile of exposure; when probabilistic assessments are conducted, the Agency regulates at the 99.9th percentile of exposure.

Dietary exposure assessments were based on the listing of tolerances eligible for reregistration as stated in the Use Closure Memo described in this document. Dietary exposure assessments were conducted for both acephate and its degradate, methamidophos. The dietary exposure assessment for methamidophos was conducted for exposure to methamidophos from application of acephate only. A dietary exposure assessment which includes exposure to methamidophos from application of methamidophos and application of acephate is discussed in the aggregate exposure assessment section of this document.

Acute and chronic dietary exposure to acephate and methamidophos (acephate application only) result in risk estimates that are below the Agency’s level of concern (<100% of the aPAD and cPAD, respectively). Residue refinements including anticipated residues generated from field trial and monitoring data, adjustments for percent crop treated, washing and cooking factors and a probabilistic/Monte Carlo acute analyses were utilized. Monitoring data for acephate and methamidophos were generated through the USDA Pesticide Data program (PDP) for succulent beans, celery and lettuce; and FDA Surveillance Monitoring data for cauliflower and peppers (acephate only; bell and non-bell). Monitoring data from the years 1994 through 1997 (PDP) and the years 1993 through 1998 (FDA) were considered. Field trial data were used for Brussels sprouts, dry beans, cottonseed, cranberry, mint, macadamia nuts, peanuts, peppers (methamidophos only), and soybean. Although FDA data were available for methamidophos on peppers, these data were not used because HED believes that these data would greatly overestimate the risk to methamidophos from application of acephate since these data represent monitoring data from application of acephate and application of methamidophos. Additionally, because fresh peppers are considered nonblended, these data would be decomposited which could further overestimate the risk.. Applying all of these refinements, the most highly exposed population subgroup for both acute and chronic dietary risk to acephate was children 1-6 years with a percent chronic population adjusted dose (% cPAD) of 17 and a %aPAD of 33% at the 99.9th percentile exposure. Exposure to the general U.S. population is 7 %cPAD and 22% of the aPAD at the 99.9th percentile. For methamidophos (acephate application only), the most highly exposed

population subgroup is children (1 to 6 years) for chronic dietary risk with an estimated exposure corresponding to 19% of the cPAD. The dietary exposure to the US population is 16% of the cPAD. Infants are the most highly exposed subpopulation for acute risk with 80% of the aPAD consumed. Estimated dietary exposure to the general US population is lower than that for infants, corresponding to 61% of the aPAD of methamidophos. Dietary risks are summarized in Table 4.

Table 4. Summary of Acephate and Methamidophos Acute and Chronic Non-Cancer Dietary Exposure and Risk Estimates

Population Subgroup	ACEPHATE				METHAMIDOPHOS			
	Acute (99.9%-ile)		Chronic		Acute (99.9%-ile)		Chronic	
	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% cPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% cPAD
US Population	0.001111	22	0.000089	7	0.000611	61	0.000016	16
All infants (<1 year)	0.000795	16	0.000185	15	0.000801	80	0.000004	4
Children 1-6 years	0.001631	33	0.000209	17	0.000790	79	0.000019	19
Children 7-12 years	0.001549	31	0.000131	11	0.000702	70	0.000018	18
Females 13-50 years	0.000879	18	0.000068	6	0.000481	48	0.000016	16

1. Acephate - The acute Population Adjusted Dose (aPAD) is 0.005 mg/kg/day ; the chronic PAD (cPAD) is 0.0012 mg/kg/day.
2. Methamidophos - The acute Population Adjusted Dose (aPAD) is 0.001 mg/kg/day ; the chronic PAD (cPAD) is 0.0001 mg/kg/day.

4.2.2 Drinking Water

Limited drinking water monitoring data are available for acephate. Therefore, the surface and ground water assessments were based on modeling predictions. STORET contains no records for acephate in samples from lakes, ocean, estuary, canal, or reservoir sites. There is a very limited number of samples taken from municipal water intakes. The NAWQA (National Water Quality Assessment) program is not currently analyzing for acephate or methamidophos and they do not have analytical methods for these chemicals in place.

4.2.2.1 Surface Water

Tier II estimated environmental concentrations (EECs) for acephate were generated using the PRZM-EXAMS model and available environmental fate data for acephate. The surface water exposure estimates were determined from the uses with the maximum yearly total applications (six aerial applications at 1 lb acephate/A/application on cotton and three aerial applications at 1.33 lb acephate/A/application on tobacco). **Based on the modeling, concentrations of acephate are not likely to exceed 82 ppb for peak (acute) exposure and 15 ppb for mean (chronic) exposure**. Surface water EECs for drinking water exposure estimates for methamidophos were generated using GENEEC assuming a 25% conversion efficiency. A Tier II assessment using PRZM-EXAMS was not conducted because of the high uncertainty surrounding any estimate of the decay rate for acephate and the transformation rate of acephate to methamidophos needed for the PRZM simulation. **The EECs for methamidophos formed as a degradate from acephate used on cotton are 22 ppb for peak(acute) and 12 ppb for mean (chronic) exposure.** It should be remembered in interpreting these results that they represent the upper limit for possible exposure from these use patterns to aquatic environments at a single high exposure site.

4.2.2.2 Ground Water

Groundwater calculations for acephate and its degradate methamidophos were based on the SCI-GROW model (Screening Concentrations in Ground Water), which is a model for estimating concentrations of pesticides in ground water under conditions of maximum exposure. SCI-GROW provides a screening concentration or an estimate of likely ground water concentration if the pesticide is used at the maximum allowed label rate in areas with ground water that is exceptionally vulnerable to contamination. A majority of the use areas will have ground water that is less vulnerable to contamination than that in the areas used to derive the SCI-GROW estimate.

The ground water Tier I EEC for both acute and chronic drinking water exposure estimates was calculated using SCI-GROW for the acephate use with the maximum yearly total application (six applications at 1 lb acephate/A/application on cotton). **The EEC for acephate was 0.02 μg/L**. **The ground water Tier I EEC for the degradate methamidophos** (assuming a 25% conversion efficiency from acephate to methamidophos at time of application, resulting in six applications at 0.25 lb methamidophos/A/application on cotton) **was 0.005 μg/L**.

4.3 Occupational and Non-Occupational Assessments

Acephate (O,S-dimethyl acetylphosphoramidothioate) is an organophosphate insecticide used to control insects on a variety of field, fruit, and vegetable crops. Pesticidal properties and toxicity are due to inhibition of acetylcholinesterase enzyme. Another registered pesticide, methamidophos (O,S-dimethyl phosphoramidothioate), is a degradate of acephate and is a potent cholinesterase inhibitor by all routes of exposure. As well as quantifying risk to acephate exposures, the occupational and non-occupational (residential and recreational) assessments will address methamidophos exposures and risks following the application of acephate products.

Acephate is currently formulated as manufacturing products (75, 97, and 98.9 % active ingredient [ai]), granulars (1.5 and 15 % ai), emulsifiable concentrates (4 and 8 % ai), wettable powders (75, 80, and 90 % ai), a pelleted/ tableted product (97 % ai), pressurized liquids (0.25, 1, 3 and 12 % ai), a ready-to-use product (75 % ai), soluble-concentrate liquids (4, 8, 9.4, 15.6, 50, 75, 90, 96 and 97 % ai), and a dust product (75 % ai). Some wettable powder formulations are contained in water-soluble packaging.

Products of acephate have been registered for both occupational and residential uses. Acephate is registered for use on the following crops: beans (snap, dry and lima), brussels sprouts, cauliflower, celery, non-bearing citrus, cotton, cranberries, head lettuce, peanuts, pepper (non-bell and sweet), peppermint/spearmint, soybeans, and tobacco. It is also used on field-grown ornamentals (i.e., trees, shrubs), pasture, rangeland, and on sod and golf course turf. In addition, acephate has registered indoor and outdoor residential uses.

Occupational applications for granular and liquid acephate formulations can be made in numerous ways. Granular acephate applications can be made by belly grinder, hand, tractor-drawn spreader, push-type spreader, and shaker can. Liquid acephate applications can be made by aircraft, airblast sprayer, backpack sprayer, chemigation, groundboom spray, hand/handtool/shaker can, handgun (hydraulic sprayer), high-pressure sprayer, hopper box (seed treatment), low-pressure handwand, seed slurry treatment, sprinkler can, and transplanting in water (tobacco).

Residential acephate applications can be made by aerosol can, shaker can, backpack sprayer, hand/handtool/shaker can, hose-end sprayer, low-pressure handwand, and sprinkler can.

Several areas of the risk assessment and characterization would improve with more data. Chemical-specific exposure studies for occupational and non-occupational (residential and recreational) exposures could refine the risk assessment. In particular, data characterizing applicator scenarios for which no data are currently available to the Agency would improve the assessment. Additionally, specific data on typical use, types of mixing and loading completed for application equipment, types of packaging available to individual and professional pesticide applicators, types of potential engineering controls, additional information on slit-placement techniques for turf applications of granules, and information on post-application techniques for all crops could also improve the assessment.

4.3.1 Occupational Assessment

4.3.1.1 Occupational Handlers

The Agency has determined that those involved in the application of acephate are likely to be exposed during acephate use. These people are generically referred to as handlers and represent those who prepare products for use (e.g., referred to as mixer/loaders), mark field for aerial application (flagger) and those who actually make the applications by driving the groundboom tractor, piloting the airplane or other piece of application equipment (referred to as applicators).

Due to the frequency and duration of acephate uses, it was determined that uses of acephate by individual and professional pesticide applicators result in short-term and intermediate-term exposures. However, the frequency and duration of these exposures do not exhibit a chronic exposure pattern (i.e., daily exposures which occur for a minimum of several months). The anticipated use patterns and current labeling indicate more than 25 exposure scenarios based upon the types of equipment that potentially can be used to make acephate applications. A summary of the use patterns incorporated into the occupational exposure assessment are described below.

4.3.1.1.1 Application Rates

These crop groupings have the following maximum application rates:

- ❏ Fruit Tree (non-bearing citrus) at 0.5 lb ai per acre;

- ❑ Field, Forage, Fiber, Small Fruit, and Vegetable Crops (including cranberries, cotton, tobacco, beans [fresh and dry], mint, peanuts, brussels sprouts, cauliflower, celery, head lettuce, non-bell peppers and sweet peppers) at 0.5 to 1.0 lb ai per acre;

- ❑ Cotton Seed Treatment (including slurry and hopper box) at 0.04 lb ai per 100 pounds of seed (when mixed before application) and 0.1875 lb ai per acre (when mixed at time of application using a drop-type spreader);

- ❑ Non Crop Areas (including field margins, pastures and wastelands) at 0.125 lb ai per acre;

- ❑ Evergreens in Large Stands (including Christmas tree plantations and various types of pine tree forests) at 0.5 to 1.0 lb ai per acre;

- ❑ Commercial Ornamentals Grown in Greenhouses at 0.5 to 1.0 lb ai per 100 gallons of water;

- ❑ Commercial Outdoor Ornamental Applications (not necessarily being grown for commercial use) [including deciduous shade trees, flowering trees and shrubs, evergreens, and roses] at 0.5 to 1.0 lb ai per 100 gallons of water;

- ❑ Commercial turf (including sod farms and golf courses) at 5.0 lb ai per acre;

- ❑ Ornamentals at residences and other public areas (including shade trees, evergreens, and roses) at 0.0076 to 0.035 lb ai per gallon, 1.5 tablespoon per mound of wettable powder for fire ant mounds, and 2 cans of 1 to 3 % ai aerosol cans for residential uses;

- ❑ Turf at residences and other public areas at 0.035 lb ai per gallon; and

- ❑ Spot Treatment at commercial and residential sites at 0.075 lb ai per gallon.

4.3.1.1.2 Methods and Types of Equipment For Mixing, Loading, and Application

The following mixing, loading and application methods are used for the previously described crop groupings:

- ❏ Fruit Trees (non-bearing citrus only) -- equipment used for commercial use includes airblast sprayer and high pressure handwand for trees;

- ❏ Field, Forage, Fiber, Small Fruit, and Vegetable Crops -- equipment used commercially includes groundboom, aerial, chemigation, and tractor-drawn drop-type spreader;

- ❏ Cotton Seed Treatment -- equipment used for commercial use includes slurry, hopper box application, and tractor-drawn drop-type spreader;

- ❏ Non-Crop Areas -- equipment used includes groundboom, handgun sprayer and aerial applications;

- ❏ Evergreens in Large Stands -- equipment used for commercial use includes airblast sprayer, aerial, and high pressure handwand;

- ❏ Commercial Ornamentals Grown in Greenhouses -- equipment used for commercial use includes low pressure handwand, backpack sprayer, high pressure handwand (mixing/loading separate), and applying soluble powder/granular by hand/handtool/shaker can;

- ❏ Commercial Outdoor Ornamental Applications -- equipment used for commercial use includes low pressure handwand, backpack sprayer, high pressure handwand (mixing/loading separate), airblast sprayer, and applying soluble powder/granular by hand/ handtool/shaker can;

- ❏ Ornamentals at Residences -- equipment used for homeowner includes backpack sprayer, low pressure handwand, applying soluble powder/granular by hand/handtool/shaker can, hose-end sprayer, and aerosol can;

- ❏ Commercial Turf -- equipment used for application to turf includes aerial application, groundboom, and handgun sprayer;

- ❏ Residential Turf -- equipment used for application to residential turf includes low pressure handwand, backpack sprayer, hose-end sprayer, and sprinkling can; and

- ❏ Spot Treatment -- equipment used for spot treatment is Pest Control Operator (PCO) injector, low pressure handwand and aerosol can.

Two chemical-specific exposure monitoring studies were submitted in support of the reregistration of acephate. Because minimal chemical-specific handler exposure data were available for the assessment, the majority of analyses for both short- and intermediate-term exposures were performed using the Pesticide Handlers Exposure Database (PHED), Version 1.1 (August 1998)

PHED was designed by a task force of representatives from the US EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts – a database of measured exposure values for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data. Currently, the database contains values for over 1,700 monitored individuals (i.e., replicates).

PHED is based upon the premise that individual handler exposures are related to how an application is made and not the specific pesticide which is being applied. The aspects of an application that are anticipated to affect exposures include: the task being performed (e.g., mixing/loading/applying); the kinds of equipment involved in application (e.g., aerial, groundboom); the nature of the

product being used (e.g., formulation and packaging); the application parameters, such as application rate and total pounds of active ingredient applied; and the personal protective equipment and engineering controls used by an individual to protect themselves during an application (e.g., additional layers of chemically-resistant clothing, chemically-resistant gloves, and closed tractor cabs).

The values calculated using PHED are called unit exposures and are generally presented as milligrams (or 1/1000th of a gram) exposure of active ingredient per pound active ingredient applied. For example, if one makes similar groundboom applications of 10 pounds of pesticide A or B, the unit exposures (1/10th of the exposure from applying 10 pounds of active ingredient A or B) would be proportional to the total amount applied and not whether pesticide A or B was in the spray tank. Separate unit exposures are typically calculated for the different equipment types that can be used in applications (e.g., open-cab groundboom and airblast applications would have different unit exposures). Separate unit exposures are also calculated for varying protective measures used during application with the same equipment. For example, there are specific unit exposures for groundboom applications for individuals while wearing normal work clothing, while wearing normal work clothing under coveralls and gloves, and while making applications using a closed cab tractor. In cases where data are not complete, the Agency uses available data and standard measures of protection to estimate exposure levels. For example, the Agency believes that the use of a coverall or a pair of chemically-resistant gloves provides a certain level of protection when worn. These levels of protection and similar exposure data are used to calculate exposures when directly applicable data are not complete.

In addition to the PHED unit exposure values used in the risk assessment, other information is needed to calculate the risk. The application rates, number of acres treated per day, body weight of handlers, and frequency of application are needed to complete the assessment. The amount of active ingredient handled per day is based upon the number of acres treated and the application rate. These values and the unit exposure values are used to calculate the daily exposure to the handler.

The Agency initially calculates the handler's risk using the least amount of protective measures. This is called the baseline assessment. For individuals involved in applications, this assessment normally accounts for an individual's normal work clothing (e.g., long sleeve shirt and long pants), no gloves, and no respirator. If there is a concern at this level, the Agency requires the use of protective measures (e.g., personal protective equipment, engineering controls) to lower the risk. Personal protective equipment (PPE) can include an additional layer of clothing, chemically-resistant gloves, and respirator. Common examples of engineering controls include: enclosed tractor cabs, closed loading systems, and water-soluble packaging.

Existing product labels generally specify which PPE should be used when handling a product. However, because the existing labels for older products were generally not based upon a risk assessment, the Agency begins its current assessments assuming baseline measures and increases protective measures until a level not of concern is obtained. Therefore, any proposed label modifications will be based on the current risk assessment rather than standard label recommendations.

Toxicity studies are required to determine the endpoints (toxic effects) which could result from worker exposures to pesticides. Studies are completed reflecting the major routes of exposure for workers: dermal and inhalation. These studies also determine exposure levels at which the toxic effects occur, as well as the highest level at which the toxic effects are unlikely to occur, called the No Observed Adverse Effect Level (NOAEL). The NOAEL and worker exposure are compared to determine risk (expressed as a Margin of Exposure [MOE = NOAEL/exposure]). The greater the MOE, the less the concern of the use. The Agency typically has concerns when MOEs are less than 100 for workers. A MOE of 100 accounts for differences between the animals used for the toxicity tests and people (inter-species extrapolation) as well as the differences which can occur among people (intra-species variability). Worker risk may result from short-term exposures (1 to 7 days) or intermediate-term exposures (1 week to several months). For acephate, the dermal and inhalation endpoints are the same (brain ChE inhibition); therefore, the margins of exposure (MOEs) for the dermal and inhalation exposure routes are combined.

More than twenty-five exposure scenarios were identified for acephate. The occupational risk assessment has been completed based upon the exposure data available to the Agency. The handler exposure and risk calculations are presented in the tables contained in Appendix A entitled *Acephate Occupational Handler Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)*. These results are for both individual and professional pesticide applicators. The exposure factors (i.e., scenario descriptors, application rates, and daily treatment) and unit exposure values at varying levels of mitigation used in the assessment are presented in Table 1 of Appendix A. The calculations of daily exposure in milligrams/day (mg/day) at the baseline risk mitigation level, absorbed daily dose (mg/kg/day), individual dermal and inhalation MOEs using ST and IT NOAELs, and combined dermal and inhalation MOEs are presented in Table 2. Tables 3 and 4 contain similar calculations for increased levels of risk mitigation -- use of additional mitigation in the form of personal protective equipment (PPE) are presented in Table 3 and use of engineering controls are presented in Table 4. The format of these tables is similar to Table 2. The only differences are the unit exposure values taken from Table 1 which represent different levels of risk mitigation. All equations used in these tables are summarized at the end of the tables.

Table 5 of Appendix A summarizes the parameters and caveats specific to the PHED exposure data used for each exposure scenario and corresponding exposure/risk assessment. These caveats include the descriptions of the source of the data and an assessment of the overall quality of the data. Generally, the assessment of the data is based upon the number of observations and the available quality control data. Quality control data are assessed based upon a grading criteria established by the PHED Task Force. Additionally, it should be noted that all calculations were completed based on current Agency policies pertaining to the completion of occupational and residential exposure/risk assessments (e.g., rounding, exposure factors and acceptable data sources).

The calculations of handler's combined dermal and inhalation risks indicate that at the highest level of mitigation available and/or feasible for a specific scenario, thirteen of the scenarios do not exceed 100. There are also five scenarios for which no exposure data are available and four scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the individual and professional pesticide acephate applicators' scenarios was 0.065 to 28,000.

4.3.1.2 Occupational Post-Application Exposure

The Agency has determined that workers may be exposed to acephate and methamidophos upon entering occupational areas which have been previously treated with acephate to perform specific work activities in these areas (e.g., scouting, staking/tieing, irrigating, harvesting). Due to the frequency and duration of post-application worker exposures, it was determined that occupational acephate uses result in potential intermediate-term dermal acephate and methamidophos post-application worker exposures. Potential inhalation exposures are not anticipated for post-application worker exposures, and the Agency currently has no policy/method for evaluating non-dietary ingestion by workers due to poor hygiene practices or smoking. As a result, only dermal exposures were evaluated in the post-application worker assessment. Four dislodgeable foliar residue studies (DFRs) and one turf transferable residue study (TTR) which address the dissipation of acephate and methamidophos in fields/greenhouses of succulent beans, cauliflower, greenhouse roses, tobacco, and turfgrass have been submitted. These studies were used to evaluate potential post-application worker risks.

Re-entry intervals (REIs) were calculated for specific tasks. Calculated REIs for succulent beans while performing harvest by hand, stake/tie, scout, and irrigate were 5 days. Calculated REIs for cauliflower while performing scout, irrigate, and harvest by hand were 0 days. Calculated REIs for greenhouse roses while sorting and packing was 6 days and while pruning and harvesting by hand was 12 days. Calculated REIs for tobacco while performing stake/tie, scout and irrigate was 8 days and while harvesting by hand was 19 days. Calculated REIs for turfgrass while mowing with tractor or push-type mower was 0 days and while harvesting sod was 1 day. It should be noted that the default REI of 24 hours will still apply to cauliflower and turf under the Worker Protection Standard.

The results are presented in the tables contained in Appendix B entitled *Acephate Post-Application Worker Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)*. Table 1 contains post-application risks to workers following two applications of acephate to succulent beans at 1.0 lb ai/A. Table 2 contains post-application risks to workers following two applications of acephate to cauliflower at 1.0 lb ai/A. Table 3 contains post-application risks to workers following two applications of acephate to greenhouse roses at 2.15 lb ai/A. Table 4 contains post-application risks to workers following three applications of acephate to tobacco at 0.77 lb ai/A. Finally, Tables 5 and 6 contain post-application risks to workers following two applications of acephate to turf at 5.0 lb ai/A. All equations used in these tables are summarized at the end of the tables.

4.3.2 Non-Occupational (Residential & Recreational) Exposure

The exposure assessment methods outlined in the Residential SOPs are used as screening tools which may overestimate or underestimate risks. EPA believes that residential risks from acephate have been overestimated when using methods outlined in the 1997 Residential SOPs. In order to improve its exposure assessment methods and develop more realistic risk assessments, the Agency developed a document entitled: *Overview of Issues Related to the Standard Operating procedures (SOPs) for Residential Exposure Assessment* (dated August 5, 1999) and presented it to SAP for review and comments. This overview was discussed during the September 21, 1999 SAP meeting. Both the document and the corresponding SAP comments (dated November 18, 1999) are available on the Internet at:

- **<http://www.epa.gov/scipoly/sap/1999/september/resid.pdf>**

and

- **<http://www.epa.gov/scipoly/sap/1999/september/finalrpt.pdf>**,

respectively.

The Agency will be revising the Residential SOPs to reflect recommendations made by the 1999 SAP and expects to issue the revised Residential SOPs in early 2000. The Agency has used the proposed revisions in the current residential risk assessment.

4.3.2.1 Residential Handlers

The Agency has determined that residential pesticide applicators are likely to be exposed during acephate use. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by residential pesticide applicators result in short-term exposures to these applicators. The anticipated use patterns and current labeling indicate several exposure scenarios based upon the types of equipment that potentially can be used to make acephate applications in the residential environment. These scenarios serve as the basis for the quantitative exposure and risk assessments. The following major residential exposure scenarios were identified for acephate:

- ❏ (1) mixing/loading/applying wettable powder using a low pressure hand wand;
- ❏ (2) mixing/loading/applying using a backpack sprayer;
- ❏ (3a) mixing/loading/applying using a hose-end sprayer;
- ❏ (3b) mixing/loading/applying using a hose-end sprayer (MRID # 405048-27);
- ❏ (4) mixing/loading/applying using a sprinkling can;
- ❏ (5) loading/applying soluble powder (dry) concentrate by hand/handtool/shaker can;
- ❏ (6) loading/applying granules by shaker can; and
- ❏ (7) applying by aerosol can.

Specific PHED data were unavailable for two residential applicator scenarios, so similar PHED data were used as surrogate data in the assessment. These scenarios are specified in Table 3 of Appendix C and summarized as follows. Surrogate data from PHED were used for scenarios (5) and (6). PHED data for granular bait dispersed by hand scenario were used for both of these scenarios.

The residential risk assessment has been completed based upon the exposure data available to the Agency. The residential pesticide applicator exposure and risk calculations are presented in the tables contained in Appendix C entitled *Acephate Non-Occupational (Residential) Exposure and Risk Assessment Tables*

(Short-Term Exposures). The exposure factors (i.e., scenario descriptors, application rates, and daily treatment) and residential unit exposure values are presented in Table 1 of Appendix C. The calculations of daily exposure in milligrams/day (mg/day), absorbed daily dose (mg/kg/day), individual dermal and inhalation MOEs using ST NOAELs, and combined dermal and inhalation MOEs are presented in Table 2. All equations used in this table are summarized at the end of the table.

Table 3 of Appendix C summarizes the parameters and caveats specific to the PHED exposure data used for each exposure scenario and corresponding exposure/risk assessment. These caveats include the descriptions of the source of the data and an assessment of the overall quality of the data. Generally, the assessment of the data is based upon the number of observations and the available quality control data. Quality control data are assessed based upon a grading criteria established by the PHED Task Force. Additionally, it should be noted that all calculations were completed based on current Agency policies pertaining to the completion of occupational and residential exposure/risk assessments (e.g., rounding, exposure factors and acceptable data sources).

It is also important to note that residential PHED values represent an applicator wearing typical residential clothing of short-sleeved shirt, short pants and no gloves. In addition, it is assumed that all residential mixing/loading scenarios are performed by open mixing and loading procedures. Homeowner uses are not covered by the Worker Protection Standard. The Agency cannot require the use of PPE and/or engineering controls for residential applicators, because the Agency can only make recommendations to residential applicators. Therefore, the use of PPE and/or engineering controls is not considered in the residential applicator risk assessment.

The calculations of residential acephate applicators' combined dermal and inhalation risks indicate that two exposure scenarios exceed 100 while six scenarios do not. The Agency has concerns for MOEs that are less than 100. The range of combined dermal and inhalation MOEs for the residential acephate applicators' scenarios was 2.9 to 7,100. There are also two scenarios for which surrogate data from similar PHED scenarios were used.

4.3.2.2 Residential Post-Application Exposure

The Agency has determined that the public may be exposed to acephate and methamidophos upon entering residential areas which have been previously treated with acephate. Due to the frequency and duration of potential post-application residential exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that residential acephate uses result in potential short-term dermal and oral acephate and methamidophos post-application residential exposures to the public. Potential inhalation exposures are not anticipated for post-application residential exposures.

It is anticipated that adults and children may primarily be exposed to acephate and methamidophos through their contact with turfgrass. Acephate and methamidophos exposures may also occur from contact (i.e., pruning, cutting and weeding) with treated ornamentals, flowers, trees, and shrubs. However, it is anticipated that these exposures would not be as significant as turfgrass exposures because of lower contact rates and the frequency and duration of potential contacts.

The following post-application residential exposures were assessed for both acephate and methamidophos: dermal exposure from residues on turf (adult and child), incidental non-dietary ingestion of residues on grass from hand-to-mouth transfer (child), and ingestion of treated grass (child). The results for acephate and methamidophos risks are presented in Tables 4 and 5, respectively, of Appendix C entitled *Acephate Non-Occupational (Residential) Exposure and Risk Assessment Tables (Short-Term Exposures)*. The screening level equations used to quantify the potential residential exposures are from the Agency's *Standard Operating Procedures for Residential Exposure Assessments (December 1997)* with the addition of standard assumptions incorporated following the 09/21/99 FIFRA SAP Meeting. All equations used in these tables are summarized at the end of the tables.

It is important to note that potential post-application residential exposures were assessed on the same day acephate would be applied to the grass. The assessment was completed in this manner, because it is assumed that the public could be exposed immediately following an acephate treatment. As a result, the average of chemical-specific TTRs measured following the second application in the turf study submitted by the registrant were used in the post-application residential assessment. An

adjustment for the difference in turf application rates between occupational and residential environments was made. It was assumed that the grass residues were equivalent to the study TTRs.

Although the residential SOPs specify that the residential exposure calculations are to be used as screening tools, the following acephate post-application residential exposure scenarios exceed the Agency's level of concern: dermal exposures to children (MOE = 86) and children's hand-to-mouth exposures (MOE = 94). None of the methamidophos post-application residential exposure scenarios exceed the Agency's level of concern (MOE range = 1,500 - 500,000).

4.3.2.3 Non-Occupational (Post-Application Recreational) Exposure

The Agency has determined that the public may be exposed to acephate and methamidophos upon entering recreational areas which have been previously treated with acephate. The recreational areas addressed in this assessment are golf courses. Due to the frequency and duration of potential post-application recreational exposures at golf courses coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses at golf courses result in potential short-term dermal acephate and methamidophos post-application recreational exposures to adults and 13+ year-olds. Potential inhalation exposures are not anticipated for post-application recreational exposures. No potential hand-to-mouth exposures were estimated for recreational exposures.

Adult and 13+ year-old golfers' exposures are anticipated to be significantly lower than post-application workers' exposures. Golfers' exposures are anticipated to occur through minimal hand contact with the golf ball and dermal exposure to the lower legs. Therefore, a default transfer coefficient of 100 has been used for the post-application recreational assessment. The results of acephate and methamidophos risks for adults and 13+ year-olds are presented in Tables 1 and 2, respectively, of Appendix D entitled *Acephate Non-Occupational (Recreational) Exposure and Risk Assessment Tables (Short-Term Exposures)*. All equations used in these tables are summarized at the end of the tables.

It is important to note that potential post-application recreational exposures were assessed on the same day acephate would be applied to the golf course. The assessment was completed in this manner, because it is assumed that the public could be exposed immediately following an acephate treatment. As a result, the average of chemical-specific TTRs measured following the second application in the turf study submitted by the registrant were used in the post-application recreational assessment.

The Agency is not concerned regarding adult and 13+ year-old golfers' risks to acephate and methamidophos following an acephate treatment of golf course turf. The calculated MOEs for adult golfers' risks to acephate and methamidophos were 7,500 and 125,000, respectively while the calculated MOEs for 13+ year-old golfers' risks to acephate and methamidophos were 4,620 and 78,100, respectively.

4.4 Incident Reports

An Incident Data Report was completed for acephate on September 8, 1999. Information from the OPP Incident Data System (IDS), the American Association of Poison Control Centers (AAPCC), the California Department of Pesticide Regulation (CDPR), and the National Pesticide Telecommunications Network (NPTN) were considered in this report.

When both Poison Control Center and California data were considered, acephate generally had a lower hazard than other organophosphate and carbamate insecticides. There have been two accidental deaths reported associated with exposure. Both deaths involved misuse and in one case use of a particulate mask may have increased the risk of inhaling acephate. Minor and moderate symptoms of exposure have often been associated with inhalation indoors. Outdoor agricultural uses are associated with lower risks of illness and poisoning than most other organophosphate and carbamate insecticides.

5. FQPA Considerations

5.1 Aggregate Exposure

In examining aggregate exposure, FQPA directs EPA to take into account available information concerning exposures from pesticide residues in food and other exposures for which there is reliable information. These other exposures include drinking water and non-occupational exposures, e.g., to pesticides used in and around the home. Risk assessments for aggregate exposure consider both short-, intermediate- and long-term (chronic) exposure scenarios considering the toxic effects which would likely be seen for each exposure duration.

Acephate is a food use chemical. Drinking Water Levels of Comparison (DWLOC) have been calculated for acephate and its degradate methamidophos. There are residential (non-occupational) uses of acephate; therefore, the considerations for aggregate exposure are those from food and residential exposure.

5.1.1 Acute and Chronic Aggregate Exposure/Risk/DWLOCs (Acephate and Methamidophos Residues (acephate application only)

Drinking Water Levels of Comparison (DWLOCs) represent the maximum contribution to the human diet, in μg/L, that may be attributed to residues of a pesticide in drinking water after dietary exposure is subtracted from the aPAD or cPAD. Acute and chronic DWLOCs for acephate and methamidophos were calculated based on dietary risk assessments using anticipated residues in food. These are presented in Tables 5 and 6. Comparisons are made between DWLOCs and the estimated concentrations of acephate and methamidophos in surface water and ground water generated via PRZM/EXAMS and SCI-GROW, respectively. If model estimate is less than the DWLOC, there is generally no drinking water concern.

Table 5. Acephate and Methamidophos (acephate application only) Summary of Chronic DWLOC Calculations

Population Subgroup	cPAD (mg/kg/day)	Food Exposure (mg/kg/day)	Available Water Exposure (mg/kg/day)	DWLOC (ug/L)	Surface Water [1] (Overall mean) (ppb)	Ground Water (SCI-GROW) (ug/L)
Acephate						
U.S. Population	0.0012	0.000089	0.001111	38	15	0.02
Females 13-50 yrs	0.0012	0.000068	0.001132	34	15	0.02
Children 1-6 yr	0.0012	0.000209	0.000991	10	15	0.02
All Infants	0.0012	0.000185	0.001015	10	15	0.02
Methamidophos						
U.S. Population	0.0001	0.000016	0.000084	3	12/3 =4	0.005
Females 13-50 yrs	0.0001	0.000016	0.000084	3	12/3 = 4	0.005
Children 1-6 yr	0.0001	0.000019	0.000081	0.81	12/3 = 4	0.005
All Infants	0.0001	0.000004	0.000096	0.96	12/3 = 4	0.005

Acephate EECs are from PRZM-EXAMS modeling.

Methamidophos EECs are from GENEEC modeling. It is the policy of HED to divide GENEEC modeling numbers by 3 for comparison to chronic DWLOC.

$$\text{DWLOC} = \frac{\text{water exposure X body weight}}{\text{Liters of water X}10^{-3}}$$

(where water exposure = cPAD - food exposure)

Body weight = 70 kg for U.S. Population, 60 kg for females, 10 kg for infants and children

Liters of water = 2L for Adults and 1L for infants and children

Table 6. Summary of Acute DWLOC Calculations

Population Subgroup	aPAD (mg/kg/day)	Food Exposure (mg/kg/day)	Available Water Exposure (mg/kg/day)	DWLOC (ug/L)	Surface Water[1] (ppb)	Ground Water (ug/L)
Acephate						
U.S. Population	0.005	0.001111	0.003889	136	82	0.02
Females 13-50 yrs	0.005	0.000879	0.00412	124	82	0.02
Children 1-6 yr	0.005	0.001631	0.003369	34	82	0.02
All Infants	0.005	0.000795	0.004205	42	82	0.02
Methamidophos						
U.S. Population	0.001	0.000611	0.000389	14	22	0.02
Females 13-50 yrs	0.001	0.000481	0.000519	16	22	0.02
Children 1-6 yr	0.001	0.000790	0.00021	2	22	0.02
All Infants	0.001	0.000801	0.000199	2	22	0.02

Acephate EECs are from PRZM-EXAMS modeling

Methamidophos EECs are from GENEEC modeling.

$$\text{DWLOC} = \frac{\text{water exposure X body weight}}{\text{Liters of water X}10^{-3}}$$

(where water exposure = cPAD - food exposure)

Body weight = 70 kg for U.S. Population, 60 kg for females, 10 kg for infants and children

Liters of water = 2L for Adults and 1L for infants and children

Chronic DWLOCs. Upon comparison of the chronic DWLOCs with the environmental concentrations of acephate estimated using conservative modeling, surface water concentrations are greater than the DWLOCs (Table 5) for infants and children. Consequently, there appears to be a potential for acephate residues in surface water to occur at levels of concern for infants and children. For methamidophos, EECs for surface water are greater than the DWLOCs for all subpopulations; therefore, there may be chronic dietary concern for methamidophos residues in drinking water from surface water sources. There is no chronic concern for drinking water from groundwater sources.

Acute DWLOCs. Acute surface water concentrations estimated using conservative modeling exceed the acute DWLOCs for acephate (infants and children) and for methamidophos (all subpopulations; ground water estimates are less than the DWLOCs (Table 6). Thus, there appears to be a potential for methamidophos residues in surface water to occur at levels of concern. There is no acute concern for drinking water from groundwater sources.

5.1.2 Acute and Chronic Aggregate Exposure/Risk/DWLOCs (Combined Methamidophos Residues from Application of Both Methamidophos and Acephate)

For chronic aggregate risk (food), chronic exposures to methamidophos from application of acephate and application of methamidophos were combined and compared to the methamidophos reference dose. This assessment was conducted using anticipated residues and BEAD % crop treated information. Results of the chronic exposure analysis show that 23% of the cPAD is consumed for the U.S. population. The most significantly exposed subpopulation, children (1 to 6 years) occupied 37.0% of the cPAD, respectively. The results indicate that HED has no concern for chronic aggregate exposure from food alone.

An acute aggregate risk (food) which considers methamidophos from application of acephate and methamidophos was also conducted. Residue refinements including anticipated residues generated from field trial and monitoring data, adjustments for percent crop treated, washing and cooking factors and a probabilistic/Monte Carlo acute analysis were utilized. Monitoring data for methamidophos (commodities with methamidophos registrations only) were generated through the USDA Pesticide Data Program (PDP) for potatoes, and tomatoes and through the FDA Surveillance Monitoring Program for peppers, squash, and strawberries. Field trial (FT) data were used for cotton. For methamidophos on commodities with only acephate registrations, the acute estimates are based on USDA Pesticide Data Program (PDP) monitoring data for succulent beans, celery and lettuce; and FDA

Surveillance Monitoring data for cauliflower and peppers (bell and non-bell). Monitoring data from the years 1994 through 1997 (PDP) and the years 1993 through 1998 (FDA) were considered. Monitoring data show that detectable residues of methamidophos are found (percent detects ranged from 1% (potatoes) - 34% (peppers)). Field trial data were used for Brussels sprouts, dry beans, cottonseed, cranberry, mint, macadamia nuts, peanuts, and soybean. Applying all of these refinements, the most highly exposed population subgroup was children 1-6 years with a %aPAD of 120%. For the general U.S. population, 79% of the aPAD was consumed. The results indicate that for infants and children, 100% of the aPAD is exceeded. Sensitivity analyses conducted show that tomatoes constitutes the majority of the dietary risk to methamidophos (Table 7).

Table 7. Aggregate Exposure: Summary of Methamidophos Acute and Chronic Non-Cancer Dietary Exposure and Risk Estimates

Population Subgroup	METHAMIDOPHOS					
	Acute (99.9%-ile)				Chronic	
	All Commodities		Excluding Tomatoes			
	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	%cPAD
General US Population	0.000787	79	0.000308	31	0.000023	23
All infants (<1 year)	0.001074	107	0.000774	77	0.000031	31
Children 1-6 years	0.001194	119	0.000604	60	0.000037	37
Children 7-12 years	0.000976	98	0.000369	37	0.000030	30
Females 13 -50 years	0.000653	65	0.000240	24	0.000021	21

1. Methamidophos - The acute Population Adjusted Dose (aPAD) is 0.001 mg/kg/day ; the chronic PAD (cPAD) is 0.0001 mg/kg/day.

An aggregate exposure assessment which quantifies risk from food and water was conducted for chronic exposure only since HED has concerns for acute aggregate exposure from food alone. Using the aggregate chronic food exposure (exposure which incorporates residues from application of methamidophos combined with residues from application of acephate), DWLOCs were calculated (Table 8). The EECs used were from modeling data derived from the use of methamidophos *per se*. For children(1 to 6 years) and infants, the results indicated the potential for slight concern from surface water sources of drinking water.

Table 8. Summary of Chronic DWLOC Calculations Incorporating Methamidophos Exposure from Application of Methamidophos and Application of Acephate

Population Subgroup	cPAD (mg/kg/day)	Food Exposure (mg/kg/day)	Available Water Exposure (mg/kg/day)	DWLOC (ug/L)	PRZM/EXAMS (Overall mean) (ppb)	SCI-GROW (ug/L)
U.S. Population	0.0001	0.000023	0.000077	3	0.9	0.028
Females 13-50 yrs	0.0001	0.000021	0.000079	2	0.9	0.028
Children 1-6 yr	0.0001	0.000037	0.000063	0.6	0.9	0.028
All Infants	0.0001	0.000031	0.000069	0.7	0.9	0.028

An **aggregate exposure assessment which quantifies risk from food, water, and residential sources** was not conducted because HED has concern regarding risks from residential exposure alone.

5.2 Cumulative Exposure To Substances with Common Mechanism of Toxicity

Section 408(b)(2)(D)(v) of the Food Quality Protection Act requires that, when considering whether to establish, modify, or revoke a tolerance, the Agency consider "available information" concerning the cumulative effects of a particular pesticide's residues and "other substances that have a common mechanism of toxicity." The Agency believes that "available information" in this context might include not only toxicity, chemistry, and exposure data, but also scientific policies and methodologies for understanding common mechanisms of toxicity and conducting cumulative risk assessments. For most pesticides, although the Agency has some information in its files that may turn out to be helpful in eventually determining whether a pesticide shares a common mechanism of toxicity with any other substances, EPA does not at this time have the methodologies to resolve the complex scientific issues concerning common mechanism of toxicity in a meaningful way. EPA has begun a pilot process to study this issue further through the examination of particular classes of pesticides. The Agency hopes that the results of this pilot process will increase the Agency's scientific understanding of this question such that EPA will be able to develop and apply scientific principles for better determining which chemicals have a common mechanism of toxicity and evaluating the cumulative effects of such chemicals. The Agency anticipates, however, that even as its understanding of the science of common mechanisms increases, decisions on specific classes of chemicals will be heavily dependent on chemical specific data, much of which may not be presently available.

Although at present the Agency does not know how to apply the information in its files concerning common mechanism issues to most risk assessments, there are pesticides as to which the common mechanism issues

can be resolved. These pesticides include pesticides that are toxicologically dissimilar to existing chemical substances (in which case the Agency can conclude that it is unlikely that a pesticide shares a common mechanism of activity with other substances) and pesticides that produce a common toxic metabolite (in which case common mechanism of activity will be assumed).

EPA has determined that acephate has a common mechanism of toxicity with other organophosphate pesticides, but has not yet determined how to include this pesticide in a cumulative risk assessment.

Acephate has a metabolite which is a registered pesticide, methamidophos. Therefore, methamidophos residues resulting from applications of both acephate and methamidophos will be considered in a cumulative risk assessment and compared to appropriate toxicological endpoints for methamidophos. This is described to some extent in the aggregate exposure section of this risk assessment document.

5.3 Endocrine Disruption

EPA is required to develop a screening program to determine whether certain substances (including all pesticides and inerts) "may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or such other endocrine effect...". The Agency is currently working with interested stakeholders, including other government agencies, public interest groups, industry and research scientists in developing a screening and testing program and a priority setting scheme to implement this program.

Appendices

Appendix A Acephate Occupational Handler Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)

Table 1: Numerical Inputs for Occupational Handler Exposure to Acephate

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
Mixer/Loader Exposure								
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	3.7	43	0.17	8.6	0.0098	0.24
	Ag = 1.0	350	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	350	3.7	43	0.17	8.6	0.0098	0.24
	Pasture = 0.125	350	3.7	43	0.17	8.6	0.0098	0.24
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	3.7	43	0.17	8.6	0.0098	0.24
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	3.7	43	0.17	8.6	0.0098	0.24
	Ag = 1.0	80	3.7	43	0.17	8.6	0.0098	0.24
	Pasture = 0.125	80	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	Sod = 80	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	Golf course = 40	3.7	43	0.17	8.6	0.0098	0.24
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	3.7	43	0.17	8.6	0.0098	0.24
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	3.7	43	0.17	8.6	0.0098	0.24
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	5	3.7	43	0.17	8.6	0.0098	0.24
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	3.7	43	0.17	8.6	0.0098	0.24
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	3.7	43	0.17	8.6	0.0098	0.24
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	3.7	43	0.17	8.6	0.0098	0.24
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.066	0.77	0.066	0.15	0.0098	0.24
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	2.9	1.2	0.023	0.24	0.0086	0.083
	Forest = 0.75	800	2.9	1.2	0.023	0.24	0.0086	0.083
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	2.9	1.2	0.023	0.24	0.0086	0.083
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.0084	1.7	0.0069	0.34	0.00017	0.034
	Sod = 5.0	80	0.0084	1.7	0.0069	0.34	0.00017	0.034
	Golf Course Turf = 5.0	40	0.0084	1.7	0.0069	0.34	0.00017	0.034

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
Applicator Exposure								
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	0.005	0.068
	Ag = 1.0	350	NF	NF	NF	NF	0.005	0.068
	Turf = 5.0	350	NF	NF	NF	NF	0.005	0.068
	Pasture = 0.125	350	NF	NF	NF	NF	0.005	0.068
	Forest = 0.75	350	NF	NF	NF	NF	0.005	0.068
	Forest = 0.75	80	NF	NF	NF	NF	0.005	0.068
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.014	0.74	0.014	0.15	0.005	0.043
	Ag = 1.0	80	0.014	0.74	0.014	0.15	0.005	0.043
	Pasture = 0.125	80	0.014	0.74	0.014	0.15	0.005	0.043
	Turf = 5.0	Sod = 80	0.014	0.74	0.014	0.15	0.005	0.043
	Turf = 5.0	Golf course = 40	0.014	0.74	0.014	0.15	0.005	0.043
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	0.36	4.5	0.24	0.90	0.14	0.45
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	0.36	4.5	0.24	0.90	0.14	0.45
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.36	4.5	0.24	0.90	0.14	0.45
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	1.3	3.9	0.39	0.78	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	1.3	3.9	0.39	0.78	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	1.3	3.9	0.39	0.78	NF	NF
	Turf = 5.0	5	1.3	3.9	0.39	0.78	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.014	0.74	0.014	0.15	0.005	0.043
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.0099	1.2	0.0072	0.24	0.0021	0.22
	Sod = 5.0	80	0.0099	1.2	0.0072	0.24	0.0021	0.22
	Golf Course Turf = 5.0	40	0.0099	1.2	0.0072	0.24	0.0021	0.22
Mixer/Loader/Applicator Exposure								
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	29	1100	8.6	220	NF	NF
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	29	1100	8.6	220	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	29	1100	8.6	220	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	29	1100	8.6	220	NF	NF
	PCO = 0.088 lb/gal	40 gal	29	1100	8.6	220	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	160	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
	PCO = 0.08745 lb/gal	4 gal	160	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
	PCO = 0.08745 lb/gal	1 gal	170	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
	PCO = 0.08745 lb/gal	40 gal	170	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	PCO = 0.088 lb/gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	3.5	120	2.5	24	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	3.5	120	2.5	24	NF	NF
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	NF	NF
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	NF	NF
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	NF	NF
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	100	470	71	94	NF	NF
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	31	9	No Data	No Data	NF	NF
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	NF	NF
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	2.9	6.3	0.73	0.63	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	10	62	20	12	NF	NF
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	100	470	71	94	NF	NF
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	100	470	71	94	NF	NF
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	100	470	71	94	NF	NF
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	100	470	71	94	NF	NF
Flagger Exposure								
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Ag = 1.0	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Turf = 5.0	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Pasture = 0.125	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Forest = 0.75	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Forest = 0.75	80	0.011	0.35	0.010	0.070	0.0011	0.035

NF = Not feasible for scenario due to nature of task or equipment (i.e., HED assumes that all agricultural aerial applications are made with enclosed cab aircraft). No Data means no data are available for the scenario.

a Maximum application rates are values found on currently registered labels.

b Amounts of acreage treated per day are from the HED estimates of acreage that could be treated in a single day for each exposure scenario of concern.

c Baseline dermal unit exposure represents a worker's estimated exposure while wearing long pants, long sleeved shirt, no gloves, open mixing/loading, open cab tractor for groundboom applications, and open flagging.

d Baseline inhalation unit exposure represents no use of a respirator.

e PPE: See Table # 5 for full description of PPE assumed for each exposure scenario. PPE generally represents the use of chemically-resistant gloves, an additional layer of clothing, and the use of an appropriate respirator.

f Engineering controls: See Table #5 for full description of engineering controls assumed for each exposure scenario. Engineering controls generally represent the use of closed mixing/loading and closed cab application equipment and a single layer of clothing (exceptions are noted individually).

Note: aerial turf application of 5 lb ai/acre is not feasible; however, it is on current labels and therefore included in this assessment.

Table 2. Baseline Clothing Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	650	7.5	9.3	0.11	1.3	1.3	0.65
	Ag = 1.0	350	1300	15	19	0.21	0.63	0.67	0.32
	Turf = 5.0	350	6500	75	93	1.1	0.13	0.13	0.065
	Pasture = 0.125	350	160	1.9	2.3	0.027	5.2	5.2	2.6
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	110	1.3	1.6	0.018	7.5	7.8	3.8
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	150	1.7	2.1	0.024	5.7	5.8	2.8
	Ag = 1.0	80	300	3.4	4.3	0.049	2.8	2.9	1.4
	Pasture = 0.125	80	37	0.43	0.53	0.0061	23	23	12
	Turf = 5.0	Sod = 80	1500	17	21	0.24	0.57	0.58	0.28
	Turf = 5.0	Golf course = 40	740	8.6	11	0.12	1.1	1.2	0.58
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	74	0.86	1.1	0.012	11	12	5.8
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	37	0.43	0.53	0.0061	23	23	12
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	19	0.22	0.27	0.0031	44	45	22

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	3.6	0.042	0.051	0.00060	240	230	120
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	37	0.43	0.53	0.0061	23	23	12
	Trees, Shrubs, Outdoor	1000 gal	19	0.22	0.27	0.0031	44	45	22
	Turf = 5.0	5	93	1.1	1.3	0.016	9.2	8.8	4.5
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	55.5	0.65	0.79	0.0093	15	15	7.5
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	296	3.4	4.3	0.049	2.8	2.9	1.5
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	56	0.65	0.80	0.0093	15	15	7.5
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	5.3	0.062	0.076	0.00089	160	160	80
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	760	0.32	11	0.0046	1.1	30	1.1
	Forest = 0.75	800	1700	0.72	24	0.010	0.50	14	0.50
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	230	0.096	3.3	0.0014	3.6	100	3.6
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.67	0.14	0.0096	0.0020	1300	70	68
	Sod = 5.0	80	3.4	0.68	0.048	0.0097	250	14	13
	Golf Course Turf = 5.0	40	1.7	0.34	0.024	0.0048	500	29	28

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Applicator Exposure									
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	NF	NF	NF
	Ag = 1.0	350	NF	NF	NF	NF	NF	NF	NF
	Turf = 5.0	350	NF	NF	NF	NF	NF	NF	NF
	Pasture = 0.125	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	80	NF	NF	NF	NF	NF	NF	NF
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.56	0.030	0.0080	0.00043	1500	330	270
	Ag = 1.0	80	1.1	0.059	0.016	0.00084	750	170	140
	Pasture = 0.125	80	0.14	0.0074	0.0020	0.00011	6000	1300	1100
	Turf = 5.0	Sod = 80	5.6	0.30	0.080	0.0043	150	33	27
	Turf = 5.0	Golf course = 40	2.8	0.15	0.040	0.0021	300	67	56
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	7.2	0.090	0.10	0.0013	120	110	59
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	3.6	0.045	0.051	0.00064	240	220	110
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	1.8	0.023	0.026	0.00033	460	420	220

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	1.3	0.0038	0.019	0.000054	630	2600	500
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	13	0.039	0.19	0.00056	63	250	50
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	6.5	0.020	0.093	0.00029	130	480	100
	Turf = 5.0	5	33	0.098	0.47	0.0014	26	100	21
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.21	0.011	0.003	0.00016	4000	880	710
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.79	0.096	0.011	0.0014	1100	100	91
	Sod = 5.0	80	4.0	0.48	0.057	0.0068	210	20	18
	Turf = 5.0	40	2.0	0.24	0.028	0.0034	430	41	37

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	5.8	0.22	0.083	0.0031	140	45	34
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	12	0.44	0.17	0.0063	71	22	17
	Wasps = 0.075 lb/1 gal	5 gal	11	0.41	0.16	0.0059	75	24	18
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	1.4	0.052	0.020	0.00074	600	190	140
	PCO = 0.088 lb/gal	40 gal	100	3.9	1.4	0.056	8.6	2.5	1.9
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	3.4	0.06	0.049	0.00086	250	160	100
	PCO = 0.08745 lb/gal	4 gal	56	0.98	0.8	0.014	15	10	5.9
	PCO = 0.08745 lb/gal	1 gal	15	0.24	0.214	0.00343	56	41	24
	PCO = 0.08745 lb/gal	40 gal	600	9.8	8.57	0.14	1.4	1	0.59

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	0.5	0.0060	0.00714	0.000086	1700	1600	830
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	1	0.012	0.0143	0.00017	840	820	420
	Wasps = 0.075 lb/1 gal	5 gal	0.94	0.011	0.0134	0.00016	890	880	450
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.12	0.0014	0.0017	0.000020	7000	7000	3500
	PCO = 0.088 lb/gal	40 gal	8.8	0.11	0.1257	0.0016	95	88	48
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	18	0.60	0.26	0.0086	46	16	12
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	35	1.2	0.50	0.017	24	8.2	6.2

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	6.94	0.0326	0.099	0.0046	120	30	24
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	0.182	0.000053	0.0026	0.0000007	4600	190000	4500
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	725	0.16	1.0	0.0023	12	61	10
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	97.9	0.606	1.4	0.0087	9	16	5.9

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	112.5	0.53	1.6	0.0075	8	19	5.9
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	99	0.4653	1.4	0.0066	8	21	5.9
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	8	0.0376	0.11	0.00054	105	260	77
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	11.25	0.0529	0.16	0.00076	75	185	56
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	1.9	0.061	0.027	0.00087	440	160	120
	Ag = 1.0	350	3.9	0.12	0.056	0.0017	210	82	59
	Turf = 5.0	350	19	0.61	0.27	0.0087	44	16	12
	Pasture = 0.125	350	0.48	0.015	0.0069	0.00021	1700	670	480
	Forest = 0.75	350	2.9	0.092	0.041	0.0013	290	110	83
	Forest = 0.75	80	6.6	0.21	0.094	0.003	130	47	34

NF = Not feasible due to equipment used. HED believes all agricultural aircraft are enclosed cab; helicopter PHED data are insufficient for evaluation. No Data means no data are available for the scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{\mathrm{MOE}derm} + \frac{1}{\mathrm{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 3: PPE Mitigation Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	30	1.5	0.43	0.021	28	6.7	5.6
	Ag = 1.0	350	60	3.0	0.86	0.043	14	3.3	2.7
	Turf = 5.0	350	300	15	4.3	0.21	2.8	0.67	0.56
	Pasture = 0.125	350	7.4	0.38	0.11	0.0054	110	26	21
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	5.1	0.26	0.073	0.0037	160	38	31
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	6.8	0.34	0.097	0.0049	120	29	23
	Ag = 1.0	80	14	0.69	0.20	0.0099	60	14	11
	Pasture = 0.125	80	1.7	0.086	0.024	0.0012	500	120	97
	Turf = 5.0	Sod = 80	68	3.4	0.97	0.049	12	2.9	2.3
	Turf = 5.0	Golf course = 40	34	1.7	0.49	0.024	24	5.8	4.8
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	3.4	0.17	0.049	0.0024	240	58	48
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	1.7	0.086	0.024	0.0012	500	120	97
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.85	0.043	0.012	0.00061	1000	230	190

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.17	0.0084	0.0024	0.00012	5000	1200	1000
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	1.7	0.086	0.024	0.0012	500	120	100
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	0.85	0.043	0.012	0.00061	1000	230	190
	Turf = 5.0	5	4.3	0.22	0.061	0.0031	200	45	37
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	2.55	0.129	0.0364	0.0018	330	76	62
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	14	0.69	0.20	0.0099	60	14	11
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	2.6	0.13	0.037	0.0019	320	74	62
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	5.3	0.012	0.076	0.00017	160	820	140
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	6.0	0.063	0.086	0.00090	140	160	77
	Forest = 0.75	800	14	0.14	0.20	0.0020	60	70	32
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	1.8	0.019	0.026	0.00027	460	520	240
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.55	0.027	0.0079	0.00039	1500	360	290
	Sod = 5.0	80	2.8	0.14	0.04	0.002	300	70	56
	Turf = 5.0	40	1.4	0.068	0.02	0.00097	600	140	110
Applicator Exposure									

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	NF	NF	NF
	Ag = 1.0	350	NF	NF	NF	NF	NF	NF	NF
	Turf = 5.0	350	NF	NF	NF	NF	NF	NF	NF
	Pasture = 0.125	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	80	NF	NF	NF	NF	NF	NF	NF
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.56	0.0060	0.0080	0.000086	1500	1600	770
	Ag = 1.0	80	1.1	0.012	0.016	0.00017	750	820	400
	Pasture = 0.125	80	0.14	0.0015	0.0020	0.000021	6000	6700	3100
	Turf = 5.0	Sod = 80	5.6	0.060	0.080	0.00086	150	160	77
	Turf = 5.0	Golf course = 40	2.8	0.030	0.040	0.00043	300	330	160
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	4.8	0.018	0.069	0.00026	170	540	130
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	2.4	0.0090	0.034	0.00013	350	1100	270
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	1.2	0.0045	0.017	0.000064	700	2200	560
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.38	0.00076	0.0054	0.000011	2200	13000	1900
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	3.9	0.0078	0.056	0.00011	210	1300	178
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	2.0	0.0039	0.028	0.000056	430	2500	370
	Turf = 5.0	5	9.8	0.0020	0.14	0.00029	86	480	71
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.21	0.00225	0.0030	0.000032	4000	4400	2100

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.58	0.019	0.0083	0.00027	1400	520	380
	Sod = 5.0	80	2.9	0.096	0.041	0.0014	290	100	77
	Golf Course Turf = 5.0	40	1.4	0.048	0.020	0.00068	600	200	150
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	1.7	0.044	0.024	0.00063	500	220	150
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	3.4	0.088	0.048	0.0013	250	110	77
	Wasps = 0.075 lb/1 gal	5 gal	3.2	0.083	0.046	0.0012	260	120	83
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.40	0.010	0.0057	0.00014	2100	1000	670
	PCO = 0.088 lb/gal	40 gal	30	0.77	0.43	0.011	28	13	9.1

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
	PCO = 0.08745 lb/gal	4 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
	PCO = 0.08745 lb/gal	1 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
	PCO = 0.08745 lb/gal	40 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	0.50	0.0012	0.0071	0.000017	1700	8200	1400
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	1.0	0.0024	0.014	0.000034	860	4100	710
	Wasps = 0.075 lb/1 gal	5 gal	0.94	0.0023	0.013	0.000033	920	4200	770
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.12	0.00028	0.0017	0.0000040	7000	35000	5900
	PCO = 0.088 lb/gal	40 gal	8.8	0.021	0.13	0.00030	92	470	77

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	13	0.12	0.19	0.0017	63	82	36
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	25	0.24	0.36	0.0034	33	41	18
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	4.9	0.0065	0.070	0.00009	170	1500	150
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	18	0.016	0.26	0.00023	46	610	42

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	196	0.117	2.8	0.0017	4.3	83	4.2
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	80	0.105	1.14	0.0015	10	93	9.1
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	70.3	0.09	1.0	0.0013	12	105	11
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	5.68	0.0075	0.08	0.0001	150	1303	150
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	8.0	0.0105	0.114	0.00015	105	926	91
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	1.8	0.012	0.026	0.00017	460	820	290
	Ag = 1.0	350	3.5	0.025	0.050	0.00036	240	390	150
	Turf = 5.0	350	18	0.12	0.25	0.0017	48	82	30
	Pasture = 0.125	350	0.44	0.0031	NA	NA	NA	NA	NA
	Forest = 0.75	350	2.6	0.018	0.038	0.00026	320	540	200
	Forest = 0.75	80	6.0	0.042	0.086	0.00060	140	230	91

NF = Not Feasible. HED believes all agricultural aircraft are enclosed cab. No Data means no data are available for the exposure scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{\text{MOE}derm} + \frac{1}{\text{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 4. Engineering Controls Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	1.7	0.042	0.025	0.00060	480	230	160
	Ag = 1.0	350	3.4	0.084	0.049	0.0012	240	120	83
	Turf = 5.0	350	17	0.42	0.25	0.0060	48	23	16
	Pasture = 0.125	350	0.43	0.011	0.0061	0.00016	2000	880	620
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	0.29	0.0072	0.0041	0.00010	2900	1400	1000
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	0.39	0.0096	0.0056	0.00014	2100	1000	670
	Ag = 1.0	80	0.78	0.019	0.011	0.00027	1100	520	360
	Pasture = 0.125	80	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Turf = 5.0	Sod = 80	3.9	0.096	0.056	0.0014	210	100	67
	Turf = 5.0	Golf course = 40	2.0	0.048	0.029	0.00069	430	200	140
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	0.20	0.0048	0.0029	0.000069	4300	2000	1400
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.049	0.0012	0.00070	0.000017	17000	8200	5600

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.0096	0.00023	0.00014	0.0000032	86000	44000	28000
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	0.049	0.0012	0.0007	0.000017	17000	8200	5600
	Turf = 5.0	5	0.25	0.0060	0.0035	0.000086	3400	1600	1100
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	0.147	0.00357	0.0021	0.000051	5700	2700	1800
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.78	0.019	0.011	0.00027	1100	520	360
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	0.15	0.0036	0.0021	0.000051	5700	2700	1800
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.78	0.019	0.011	0.00027	1100	520	360
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	2.3	0.022	0.032	0.00031	380	450	208
	Forest = 0.75	800	5.2	0.050	0.074	0.00071	160	200	91
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.69	0.0066	0.0098	0.000094	1200	1500	670
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.014	0.0027	0.00020	0.000038	60000	3700	3400
	Sod = 5.0	80	0.068	0.014	0.00097	0.0002	12000	700	670
	Golf Course Turf = 5.0	40	0.034	0.0068	0.00048	0.000097	25000	1400	1300

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Applicator Exposure									
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	0.88	0.012	0.013	0.00017	920	820	430
	Ag = 1.0	350	1.8	0.024	0.026	0.00034	480	410	220
	Turf = 5.0	350	8.8	0.12	0.13	0.0017	92	82	43
	Pasture = 0.125	350	0.22	0.0030	0.0031	0.000043	3900	3300	1800
	Forest = 0.75	350	1.3	0.018	0.019	0.00026	630	540	290
	Forest = 0.75	80	3.0	0.041	0.043	0.00059	280	240	130
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.20	0.0017	0.0028	0.000024	4300	5800	2500
	Ag = 1.0	80	0.40	0.0034	0.0057	0.000048	2100	2900	1200
	Pasture = 0.125	80	0.050	0.00043	0.00071	0.0000061	17000	23000	10000
	Turf = 5.0	Sod = 80	2.0	0.017	0.029	0.00024	410	580	240
	Turf = 5.0	Golf course = 40	1.0	0.0086	0.014	0.00012	860	1200	500
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	2.8	0.0090	0.040	0.00013	300	1100	240
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	1.4	0.0045	0.020	0.000064	600	2200	450
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.7	0.0023	0.010	0.000033	1200	4200	910
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Turf = 5.0	5	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.75	0.000645	0.011	0.0000092	1100	15000	1000
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.17	0.018	0.0024	0.00026	5000	540	500
	Sod = 5.0	80	0.84	0.088	0.012	0.0012	1000	120	110
	Golf Course Turf = 5.0	40	0.42	0.044	0.0060	0.00063	2000	220	200
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.088 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	4 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	1 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.088 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No data	NF	NF	NF	NF	NF	NF	NF
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No data	NF	NF	NF	NF	NF	NF	NF
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No data	NF	NF	NF	NF	NF	NF	NF
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	NF	NF	NF	NF	NF	NF	NF
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	NF	NF	NF	NF	NF	NF	NF
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	NF	NF	NF	NF	NF	NF	NF
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	NF	NF	NF	NF	NF	NF	NF
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	NF	NF	NF	NF	NF	NF	NF
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	NF	NF	NF	NF	NF	NF	NF
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	NF	NF	NF	NF	NF	NF	NF
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	0.19	0.0061	0.0027	0.000087	4400	1600	1200
	Ag = 1.0	350	0.39	0.012	0.0056	0.00017	2100	820	590
	Turf = 5.0	350	1.9	0.061	0.27	0.00874	440	160	120
	Pasture = 0.125	350	0.048	0.0015	0.00068	0.000021	18000	6700	4800
	Forest = 0.75	350	0.29	0.092	0.0041	0.0013	2900	110	110
	Forest = 0.75	80	0.66	0.021	0.0094	0.0003	1300	470	340

NF = Not Feasible; no engineering controls exist or HED does not consider engineering controls an effective approach for mitigating exposure during the use of certain types of equipment. No Data means no data are available for the exposure scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{\mathrm{MOE}derm} + \frac{1}{\mathrm{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 5. Occupational Handler Exposure Scenario Descriptions for the Use of Acephate

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
MIXER/LOADER DESCRIPTORS			
(1a/1b/1c/1d/1e/1f/1g/1h) Mixing/Loading Soluble Powder	PHED V1.1	350 acres for aerial application/ chemigation; 80 acres for groundboom on agricultural; 40 acres for groundboom on golf courses; 40 acres for airblast application (1,000 gallons used for trees&shrubs and outdoor floral); 13 gallons/acre and 6 acres for fire ant control; 1,000 gallons and 5 acres for hydraulic sprayer; 200,000 lb seed for slurry seed treatment; 20 acres for transplanting on a tobacco farm; and 80 acres for hopper box application Note: aerial turf application of 5 lb ai/acre is not feasible; however, it is on current label and therefore included in this assessment Note: Per comments received by the Agency, 30 acres are being used for the treated area of cranberries in this assessment; the Agency requires additional exposure monitoring data, use information and cultural practices with regard to treatment of cranberries; label modifications with regard to the maximum acreage should be made. Note: PHED data for wettable powders have been used due to the lack of data for soluble powders	**Baseline:** Hand and dermal data are ABC grades, and inhalation data are ABC grades. Hand = 7 replicates; dermal = 22 to 45 replicates; and inhalation = 44 replicates. Low confidence in hand data due to the low number of hand replicates. Medium confidence in dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are AB grade with 24 replicates and a high confidence level. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hands and Dermal =ABC grades; Inhalation=ABC grades. Hands = 5 replicates; Dermal= 6 to 15 replicates; Inhalation = 12 replicates; Low confidence all data. No protection factor was needed to define the unit exposure value. Engineering controls are based on water soluble packets.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(2) Mixing/ Loading Dry Flowable	PHED V1.1	200,000 pounds of seed	**Baseline:** Hand and dermal data are AB grades, and inhalation data are AB grades. Hand = 7 replicates; dermal = 16 to 26 replicates and inhalation = 23 replicates. Low confidence in hand data due to the low number of hand replicates. High confidence in dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are ABC grade with 34 replicates and a medium confidence level. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hands and Dermal =ABC grades; inhalation = ABC grades. Hands = 5 replicates; Dermal= 6 to 15 replicates; Inhalation = 12 replicates; Low confidence all data. No protection factor was needed to define the unit exposure value. Engineering controls are based on water soluble packets. No additional information was provided by the registrant regarding the use of engineering controls.
(3a/3b) Mixing/Loading Liquids	PHED V1.1	350 acres, for agricultural settings; 800 acres used for forest application; and 200,000 lb of cotton seed.	**Baseline**: Hand and dermal are AB grades, and inhalation are AB grades. Hand replicates =53 replicates; Dermal = 71 to 121 replicates; and inhalation = 85 replicates. High confidence in hand/dermal and inhalation data. No protection factor was needed to define the unit exposure. **PPE** :The same dermal data are used as for baseline. Hands = AB grades, replicates = 59. The same inhalation data are used as for the baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls :** Hand and dermal unit exposure are ABC grades. Hand = 31 replicates; and dermal=30 to 36 replicates. Medium confidence in dermal and hand data. Inhalation are AB grades; replicates = 27. High confidence in inhalation data. Gloves are worn during the use of engineering controls. No protection factor was needed to define the unit exposure value.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(4) Mixing/Loading Granular	PHED V1.1	80 acres for cotton; 80 acres for sod; and 40 acres for golf course turf	**Baseline:** Hand data are all grades, dermal are ABC grades, and inhalation are AB grades. Hand = 10 replicates; dermal = 33 to 78 replicates; and inhalation = 58 replicates. Low confidence in hand data, medium confidence in dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same inhalation data are used as for baseline coupled with an 80% protection factor to simulate the use of a dust/mist respirator. Hand data are AB grades with 45 replicates, and high confidence level. **Engineering Controls:** The same data are used as for baseline with a 98% protection factor to simulate the use of a closed mixing system.
APPLICATOR DESCRIPTIONS			
(5) Applying Sprays with Fixed Wing Aircraft	PHED V1.1	350 acres for crops and 800 acres for forest	**Baseline:** No data. **PPE:** No data. **Engineering Controls:** Hands = AB grade, dermal and inhalation=ABC grade. Hands=34 replicates; dermal =24 to 48 replicates, and inhalation =23 replicates. Medium Confidence in dermal and inhalation data; high confidence in hand data. No Protection factor was needed to define the unit exposure value.
(6) Applying with Ground Boom Sprayer	PHED V1.1	80 acres (agriculture) and 40 acres (golf course)	**Baseline:** Hand, dermal, and inhalation data=AB grades. Hand = 29 replicates; dermal = 23 to 42 replicates; and inhalation = 22 replicates. High confidence in hand/dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. Hand data are ABC grades, with 21 replicates, and medium confidence level. **Engineering Controls:** Hand and dermal data are ABC grades, and inhalation are AB grades. Hand = 16 replicates; dermal =20 to 31 replicates; inhalation = 16 replicates. Medium confidence in hand/dermal data, and high confidence in inhalation data.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(7) Applying with Airblast Sprayer	PHED V1.1	40 acres and 1,000 gallons	**Baseline**: Hands = ABC grades; dermal and inhalation = AB grades. Hands= 31 replicates, dermal = 31 to 48 replicates ; and inhalation= 47 replicates. High confidence in the dermal and inhalation data; medium confidence in hand data; No protection factor was needed to define the unit exposure. **PPE**: The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. Dermal = AB grades with 31 to 48 replicates and high confidence level. Hands= AB grades with 18 replicates, and high confidence level. **Engineering Controls:** Hands and Dermal =AB grade and Inhalation=ABC grade. Hands = 20 replicates (no glove data back calculated from glove data assuming a 90% protection factor for gloves); dermal =20 -30 replicates and inhalation =9 replicates. High confidence in hands and dermal data and low confidence in inhalation data.
(8) Applying Spray with Handgun Sprayer	PHED V1.1	Fire Ants 13 gal/acre and 6 acres gallons; trees & shrubs 1,000 gal; and turf 5 acres	**Baseline:** Hand data are AB grades, dermal data are ABC grades, and inhalation data are A grades. Hand = 16 replicates; dermal = 4 to 20 replicates; and inhalation = 16 replicates. Low confidence in dermal data, and high confidence in hand and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are AB grades with 4 replicates and low confidence level. The same inhalation data are used as for the baseline coupled with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(9) Applying in Transplanting Water	PHED V1.1	20 acres	No PHED data were available for this scenario; therefore, PHED data for groundboom were used (which may over-estimate transplant water application for tobacco). See scenario (7)
(10) Applying in Seed Treatment Hopper Box	No Data	No Data	NA
(11) Applying as a Seed Treatment in a Slurry Tank	No Data	No Data	NA

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	PHED V1.1	80 acres for cotton; 80 acres for sod; and 40 acres for golf course turf	**Baseline:** Hand and dermal data are AB grade, and inhalation data are AB grade. Hand = 5 replicates; dermal = 1 to 5 replicates; and inhalation = 5 replicates. Low confidence in hand/dermal data, and low confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data (gloved) are estimated from no gloves data using a 90% protection factor. The same inhalation data are used as for the baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hand, dermal, and inhalation are AB grades. Hand = 24 replicates; dermal = 2-30 replicates; and inhalation = 37 replicates. High confidence in hand, and inhalation data; low confidence in dermal data.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
MIXER/LOADER/APPLICATOR			
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	PHED V1.1	40 gallons for floral crops and 5 gallons for Wasps and Fire ants	**Baseline:** Hand data are AB grades, dermal are ABC grades, and inhalation data are ABC grades. Hand = 15 replicates, back calculated from glove data assuming a 90% protection factor from gloves; dermal = 16 replicates; and inhalation = 16 replicates. Medium confidence in hand, dermal and inhalation data. **PPE:** The same dermal, hand, and inhalation data are used as for baseline with an 80% protection factor for inhalation unit exposure to simulate the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand	MRID 405048-23	crack and crevice treatment at residential sites: 1 qt finished product/house; range of 1 to 20 houses/day commercial sites: range of 1 to 20 gallons finished product per day	9 replicates for residential sites 9 replicates for commercial sites
(14) Mixing/Loading/Applying Using Backpack Sprayer	PHED V1.1	40 gallons; for floral crops; 5 gallons for Wasps and Fire ants	**Baseline:** Hand data are ABC grade, dermal are AB grades, and inhalation data are A grades. Hand = 11 replicates (with gloves); dermal = 9 to 11 replicates; and inhalation = 11 replicates. Low confidence in hand/dermal and inhalation data. **PPE:** The same dermal, hand, and inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(15) Mixing/Loading/Applying using High Pressure Sprayer	PHED V1.1	1,000 gallons	**Baseline:** Hands = ABC grade; dermal = AB grades; and inhalation = A grades. Hands = 13 replicates, back calculated from glove data using a 90% protection factor; dermal = 7 to 13 replicates; and inhalation= 13 replicates. Low confidence in hands, dermal and inhalation data. **PPE:** The same dermal data are used as for baseline couple with a 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(16) Loading/Applying Using Aerosol Generator	No Data	---	No Data

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(17) Loading/Applying with PCO injector	No Data	---	See scenario 14(b) for similar scenario for crack and crevice treatment
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can	PHED V1.1	10 mounds /acre and 1 acre	No PHED data were available for this scenario. Therefore, PHED data for the granular bait dispersed by hand scenario were used. See scenario (24).
(19) Mixing/Loading /Applying Soluble Powder using Sprinkler Can	No Data	1 gal/mound; 10 mound/acre; and 1 acre	No PHED data were available for this scenario. Therefore, PHED data for the garden hose-end sprayer were used. **Baseline:** Dermal and inhalation = ABC grade, hands = E grade; dermal = 8 replicates, hands = 8 replicates, inhalation = 8 replicates; A 50% protection factor was used to simulate long pants and long sleeve shirts.
(20) Loading/Applying Tree Injections	No Data	No Data	NA
(21) Mixing/Loading/Applying Granular with Push-Type Granular Spreader	PHED V1.1	5 acres for turf	**Baseline:** Hand and dermal = C grade and inhalation = acceptable grades. Hand = 15 replicates; dermal = 0 to 15 replicates; and inhalation = 15 replicates. Low to medium confidence in the dermal and hand data. High confidence in the inhalation data. No protection factor was required to define the unit exposure scenario. **PPE:** Derived by calculation from baseline data. The same dermal data and hand data are used (as for the baseline) with a 50% protection factor applied to non-hand dermal data to account for the use of an additional layer of clothing (coveralls), a 90% protection factor to hand data to account for the use of chemically-resistant gloves, and a 90% PF was applied to account for the use of appropriate respiratory protection. **Engineering Controls:** There are no known engineering controls for this scenario.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(22) Loading/ Applying Granular with Belly Grinder	PHED V1.1	2 acres	**Baseline:** Hand and dermal data are ABC grades, and inhalation data are AB grades. Hand = 23 replicates; dermal = 29 to 45 replicates; and inhalation = 40 replicates. Medium confidence in hand/dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are ABC grade with 15 replicates and medium confidence level. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(23) Loading/Applying/ Granular with Shaker Can	PHED V1.1	10,000 sq. ft	No PHED data were available for this scenario; therefore, PHED data for the granular bait dispersed by hand scenario were used. See scenario (24)
(24) Loading/Applying Granular by Hand	PHED V1.1	1000 pots	**Baseline:** Hand, dermal and inhalation data are ABC grades. Hands=15 replicates, back calculated from glove data assuming a 90% protection factor; dermal =16 replicates and inhalation =16 replicates. Medium confidence in hand, dermal and inhalation data. **PPE:** The same dermal, hands, and inhalation data are used as for baseline with a 80% protection factor for inhalation unit exposure value to simulate the use of a dust/mist respirator **Engineering Controls**: There is the possibility of mechanical application; however, for this scenario extrapolation is not appropriate.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
FLAGGER DESCRIPTORS			
(25) Flagging Aerial Applications	PHED V1.1	350 acres agricultural and 800 acres forest	**Baseline:** Hands, dermal and inhalation AB grades. Dermal =18 to 28 replicates; Hands =30 replicates; and inhalation=28 replicates. High confidence in dermal, hands, and inhalation data. **PPE**: The same dermal data are used as for baseline. Hand data are AB grades with 6 replicates and low confidence. The same inhalation data are used as for baseline coupled with a 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** The same data are used as for baseline with a 90% protection factor to simulate a closed cab.

a Standard Assumptions based on an 8-hour work day as estimated by HED. BEAD data were not available.

b These grades are based on Quality Assurance/Quality Control data provided as part of the exposure studies. A replicate refers to data acquired during one complete work cycle. All handler exposure assessments in this document are based on the "Best Available" data as defined by HED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments.) Best available grades are assigned as follows: matrices with grades A and B data (which is defined as acceptable grade data) and a minimum of 15 replicates; if not available, then grades A, B, and C data and a minimum of 15 replicates; if not available, then all data (all grades) regardless of the quality and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection.

Data confidence as reported in the Table refers to both the quality and the quantity (number of replicates) of data for each PHED run. Each study in PHED has been graded from A to E. A high confidence run yields grades A and B data and 15 or more replicates per body part. Any combination of A and B grade data are listed as acceptable grades data in the tables. A medium confidence run yields grades A, B, and C data and 15 or more replicates per body part. Any combination of A, B, and C grade data are listed as ABC grade data in the tables. A low confidence run yields all grades (any run that includes D or E grade data) or has less than 15 replicates per body part.

Note: PHED data for wettable powders have been used due to the lack of data for soluble powders.

Appendix B Acephate Occupational Post-Application Worker Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)

Table 1. Post-Application Risks to Workers Following Acephate Application to Beans in OR (1.0 lb ai/acre -- 2 applications)

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Calculated DFR ($\mu g/cm^2$)	S/T, S, I & H Dose (mg/kg/day)	MOE	Calculated DFR1 ($\mu g/cm^2$)	S/T, S, I & H Dose (mg/kg/day)	MOE
0	0.6063	0.277	43	0.02815	0.013	58
1	0.4961	0.227	53	0.02506	0.011	65
2	0.4059	0.186	65	0.02230	0.010	74
3	0.3321	0.152	79	0.01985	0.009	83
4	0.2718	0.124	97	0.01767	0.008	93
5	**0.2224**	**0.101**	**118**	**0.01573**	**0.007**	**104**

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.

S/T, S, I & H = Stake/Tie, Scout, Irrigate & Harvest

S/T, S, I & H Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (4,000 cm^2/hr for bean harvest by hand, stake/tie, scout and irrigate) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Table 2. Post-Application Risks to Workers Following Acephate Application to Cauliflower in CA (1.0 lb ai/acre -- 2 applications)

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Average DFR (μg/cm^2)	Scout/Irrigate Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	Scout/Irr MOE	Harvest MOE	Average DFR (μg/cm^2)	Scout/Irrigate Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	Scout/Irr MOE	Harvest MOE
0	0.2003	0.023	0.057	522	210	0.0029	0.00033	0.00083	2270	900

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) averaged from actual field measurements made following the second application.

Scout/Irrigate Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (1,000 cm^2/hr for cauliflower scouting/irrigating) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Harvest Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (2,500 cm^2/hr for cauliflower harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective scout/irrigate and harvest doses are used to determine the scout/irrigate and harvest MOEs. MOE of 100 is acceptable margin of exposure.

Table 3. Post-Application Risks to Workers Following Acephate Application to Greenhouse Roses in CA (2.15 lb ai/acre -- 2 applications)

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Calculated DFR (μg/cm^2)	Sort/Pack Dose (mg/kg/day)	Prune/Harvest Dose (mg/kg/day)	Sort/Pack MOE	Prune/Harv MOE	Calculated DFR (μg/cm^2)	Sort/Pack Dose (mg/kg/day)	Prune/Harvest Dose (mg/kg/day)	Sort/Pack MOE	Prune/Harv MOE
0	1.517	0.433	1.734	28	7	0.03150	0.009	0.036	83	21
1	1.206	0.344	1.378	35	9	0.02713	0.008	0.031	97	24
2	0.9584	0.274	1.095	44	11	**0.02336**	**0.007**	0.027	**112**	28
3	0.7617	0.218	0.870	55	14	0.02012		0.023		33
4	0.6054	0.173	0.692	69	17	0.01732		0.020		38
5	0.4812	0.137	0.550	87	22	0.01492		0.017		44
6	**0.3824**	**0.109**	0.437	**110**	27	0.01284		0.015		51
7	0.3039		0.347		35	0.01106		0.013		59
8	0.2416		0.276		43	0.009523		0.011		69
9	0.1920		0.219		55	0.0082		0.009		80
10	0.1526		0.174		69	0.007061		0.008		93
11	0.1213		0.139		87	**0.006081**		**0.007**		**108**
12	**0.09639**		**0.110**		**109**					

NOTE: Values rounded; calculations are based on spreadsheet analyses.
Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.
Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.
Sort/Pack Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (2,500 cm^2/hr for roses sorting and packing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Prune/Harvest Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (10,000 cm^2/hr for roses pruning and harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective sort/pack and prune/harvest doses are used to determine the sort/pack and prune/harvest MOEs.
MOE of 100 is acceptable margin of exposure.

Table 4. Post-Application Risks to Workers Following Acephate Application to Tobacco in NC (0.77 lb ai/acre -- 3 applications)

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Calculated DFR (μg/cm^2)	S/T, S & I Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	S/T, S & I MOE	Harvest MOE	Calculated DFR (μg/cm^2)	S/T, S & I Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	S/T, S & I MOE	Harvest MOE
0	0.3139	0.143	0.359	84	33	0.03145	0.014	0.036	52	21
1	0.2745	0.125	0.314	96	38	0.02884	0.013	0.033	57	23
2	**0.2400**	**0.110**	0.274	**109**	44	0.02644	0.012	0.030	62	25
3	0.2099		0.240		50	0.02425	0.011	0.028	68	27
4	0.1836		0.210		57	0.02224	0.010	0.025	74	30
5	0.1605		0.183		65	0.02040	0.009	0.023	80	32
6	0.1404		0.160		75	0.01870	0.009	0.021	88	35
7	0.1228		0.140		86	0.01715	0.008	0.020	96	38
8	0.1074		0.123		98	**0.01573**	**0.007**	0.018	**104**	42
9	**0.09389**		**0.107**		**112**	0.01442		0.016		45
10						0.01323		0.015		50
11						0.01213		0.014		54
12						0.01112		0.013		59
13						0.01020		0.012		64
14						0.009355		0.011		70
15						0.008579		0.010		76
16						0.007867		0.009		83
17						0.007214		0.008		91
18						0.006616		0.008		99
19						**0.006067**		**0.007**		**108**

NOTE: Values rounded; calculations are based on spreadsheet analyses.
Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.
Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.
S/T, S & I = Stake/Tie, Scout & Irrigate
S/T, S & I Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (4,000 cm^2/hr for tobacco stake/tie, scouting & irrigating) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Harvest Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (10,000 cm^2/hr for tobacco harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective S/T, S & I and harvest doses are used to determine the S/T, S & I and harvest MOEs. MOE of 100 is acceptable margin of exposure.

Table 5A. Post-Application Risks to Workers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications)

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Average TTR (μg/cm^2)	Tractor Mow Dose (mg/kg/day)	Push-type Mow Dose (mg/kg/day)	Tractor Mow MOE	Push-type Mow MOE	Average TTR (μg/cm^2)	Tractor Mow Dose (mg/kg/day)	Push-type Mow Dose (mg/kg/day)	Tractor Mow MOE	Push-type Mow MOE
0	**0.289**	**0.016**	**0.033**	**750**	**364**	**0.00106**	**0.000060**	**0.00012**	**12500**	**6250**

NOTE: Values rounded; calculations are based on spreadsheet analyses.
Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.
Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.
Tractor Mow Dose (mg/kg/day) = TTR (μg/cm^2) * Transfer Coefficient (500 cm^2/hr for tractor mowing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Push-type Mow Dose (mg/kg/day) = TTR (μg/cm^2) * Transfer Coefficient (1,000 cm^2/hr for push-type mowing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective tractor mow and push-type mow doses are used to determine the tractor mow and push-type mow MOEs. MOE of 100 is acceptable margin of exposure.

Table 5B. Post-Application Risks to Workers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications)

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average TTR (μg/cm^2)	Harvest Dose (mg/kg/day)	MOE	Average TTR (μg/cm^2)	Harvest Dose (mg/kg/day)	MOE
0	0.289	0.33	36	**0.00106**	**0.0012**	**625**
1	**0.0391**	**0.045**	**267**			

NOTE: Values rounded; calculations are based on spreadsheet analyses.
Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.
Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.
Harvest Dose (mg/kg/day) = TTR (μg/cm^2) * Transfer Coefficient (10,000 cm^2/hr for sod harvesting) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.
Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Appendix C Acephate Non-Occupational (Residential) Exposure and Risk Assessment Tables (Short-Term Exposures)

Table 1. Numerical Inputs for Non-Occupational (Residential) Handler Exposure to Acephate

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Residential Unit Values	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)
Residential Exposure				
(1) Mixing/Loading/Applying Wettable Powder Using a Low Pressure Hand Wand	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	2 gallons	250	1100
	Turf = 0.035 lb / gal	2 gallons	250	1100
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	250	1100
(2) Mixing/Loading/Applying Using a Backpack Sprayer	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb (4.5 grams) / gal	2 gallons	5.1	30
	Turf = 0.035 lb / gal	2 gallons	5.1	30
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	5.1	30
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	Ornamentals, Flowers, Shrubs, Trees = 0.023 lb / gal	50 gallons	30	9.5
	Turf = 0.035 lb / gal	50 gallons	30	9.5
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	50 gallons	30	9.5
	Shade Trees = 0.013 lb / gal (LUIS)	50 gallons	30	9.5
	Ornamentals and Turf = 0.058 lb / 1000 sq ft (LUIS)	20,000 sq ft (0.5 A)	30	9.5
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer [MRID # 405048-27]	Shrubbery = 0.01175 lb / gal	50 gallons	480	150
(4) Mixing/Loading/Applying Using a Sprinkling Can	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	5 gallons	30	9.5
	Turf = 0.035 lb / gal	5 gallons	30	9.5
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	5 gallons	30	9.5
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	Fire Ants = 0.0069 lb / mound	7 mounds	430	470

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Residential Unit Values	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)
(6) Loading/Applying Granules by Shaker Can **(NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant)**	Ornamentals = 0.5 lb / 1000 sq ft	100 sq ft	430	470
	Roses = 0.1125 lb / 1000 sq ft	5 sq ft / rose; 20 roses	430	470
(7) Applying by Aerosol Can	Crack & Crevice = 0.01 lb / can	2 cans (32 oz)	220	2400
	Ornamentals = 0.03 lb / can	2 cans (32 oz)	220	2400

a Application rates are values found on currently registered labels, through Agency sources (LUIS) and from information provided by the registrant.

b Amounts of acreage treated per day are from the HED estimates of acreage that could be treated in a single day for each exposure scenario of concern, through other Agency sources (LUIS) and from information provided by the registrant.

c Baseline dermal unit exposure represents an individual's estimated exposure while wearing short pants, short sleeved shirt, no gloves, open mixing/loading.

d Baseline inhalation unit exposure represents no use of a respirator.

Table 2. Exposure and Risks for Non-Occupational (Residential) Handlers of Acephate

RESIDENTIAL Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Residential Exposure									
(1) Mixing/Loading/Applying Wettable Powder Using a Low Pressure Hand Wand	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	2 gallons	12	0.051	0.17	0.00073	70	190	53
	Turf = 0.035 lb / gal	2 gallons	18	0.077	0.26	0.0011	46	130	33
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	3.8	0.017	0.054	0.00024	220	580	160
(2) Mixing/Loading/Applying Using a Backpack Sprayer	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb (4.5 grams) / gal	2 gallons	0.23	0.0014	0.0033	0.00002	3600	7000	2400
	Turf = 0.035 lb / gal	2 gallons	0.36	0.0021	0.0051	0.00003	2400	4700	1600
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	0.078	0.00046	0.0011	0.0000065	11000	22000	7100
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	Ornamentals, Flowers, Shrubs, Trees = 0.023 lb / gal	50 gallons	35	0.011	0.50	0.00016	24	880	23
	Turf = 0.035 lb / gal	50 gallons	53	0.017	0.76	0.00024	16	580	16
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	50 gallons	11	0.0036	0.16	0.000051	75	2700	73
	Shade Trees = 0.013 lb / gal (LUIS)	50 gallons	20	0.0062	0.29	0.000088	41	1600	40
	Ornamentals and Turf = 0.058 lb / 1000 sq ft (LUIS)	20,000 sq ft (0.5 A)	35	0.011	0.50	0.00016	24	880	23
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer [MRID # 405048-27]	Shrubbery = 0.01175 lb / gal	50 gallons	280	0.088	4.0	0.0012	3.0	120	2.9

RESIDENTIAL Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(4) Mixing/Loading/Applying Using Sprinkling Can	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	5 gallons	3.5	0.0011	0.05	0.000016	240	8800	230
	Turf = 0.035 lb / gal	5 gallons	5.3	0.0017	0.076	0.000024	160	5800	160
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	5 gallons	1.1	0.00036	0.016	0.0000051	750	27000	730
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	Fire Ants = 0.0069 lb / mound	7 mounds	21	0.022	0.30	0.00031	40	450	37
(6) Loading/Applying Granules by Shaker Can **(NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant)**	Ornamentals = 0.5 lb / 1000 sq ft	100 sq ft	22	0.024	0.31	0.00034	39	410	36
	Roses = 0.5 lb / 1000 sq ft	5 sq ft / rose; 20 roses	22	0.024	0.31	0.00034	39	410	36
(7) Applying by Aerosol Can	Crack & Crevice = 0.01 lb / can	2 cans (32 oz)	4.4	0.048	0.063	0.00069	190	200	97
	Ornamentals = 0.03 lb / can	2 cans (32 oz)	13	0.14	0.19	0.002	63	70	33

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{MOE derm} + \frac{1}{MOE inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 3: Non-Occupational (Residential) Exposure Scenario Descriptions for the Use of Acephate

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b, c]
(1) Mixing/Loading /Applying Wettable Powder Using a Low Pressure Hand Wand	PHED V1.1	2 gallons (per registrant; label modification required to reflect such)	**Residential:** Hand data are grade A, dermal data are C grade, and inhalation data are C grade. Hand = 15 replicates; dermal = 16 replicates; and inhalation = 16 replicates. High confidence in hand data . Medium confidence in inhalation and dermal data. A 90% protection factor was needed to "back calculate" a no glove unit exposure value from all non-detects.
(2) Mixing /Loading/Applying Using a Backpack Sprayer	PHED V1.1	2 gallons (per registrant; label modification required to reflect such)	**Residential:** Hand is grade C, dermal data are AB grades, and inhalation data are A grade. Hand = 11 replicates; dermal = 9-11 replicates and inhalation = 11 replicates. Low confidence in hand/dermal/ inhalation data. A 90% protection factor was needed to "back calculate" a no glove unit exposure value from all non-detects.
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	PHED V1.1	50 gallons of spray solution and 20,000 sq ft (0.5 acre) for turf	**Residential:** Dermal =C grade; Hands =E grade and inhalation =C grade. Hand = 8 replicates; Dermal = 8 replicates; and inhalation = 8 replicates. Low confidence in dermal, hand and inhalation data.
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer	MRID # 405048-27	50 gallons	5 replicates
(4) Mixing/ Loading /Applying Using Sprinkling Can	PHED V1.1	5 gallons	**Residential:** Dermal,=C grade; Hands =E grade and inhalation=C grade. Hand =8 replicates; Dermal = 8 replicates; and inhalation = 8 replicates. Low confidence in dermal, hand and inhalation data.
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	PHED V1.1	7 mounds	No PHED data were available for this scenario; therefore, used the PHED data for the granular bait dispersed by hand scenario. **Residential:** Dermal = ABC grades, Hand = ABC grades; dermal/hands = 16 replicates, Inhalation = ABC grades, inhalation = 16 replicates. Medium confidence in dermal and inhalation data.
(6) Loading/Applying Granules by Shaker Can	PHED V1.1	100 sq ft and 5 sq ft/rose for 20 roses NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant; label modification required to reflect such	No PHED data were available for this scenario; therefore, used the PHED data for the granular bait dispersed by hand scenario. **Residential:** Dermal = ABC grades, Hand = ABC grades; dermal/hands = 16 replicates, Inhalation = ABC grades, inhalation = 16 replicates. Medium confidence in dermal and inhalation data.
(7) Applying By Aerosol Can	PHED V1.1	2 cans (32 oz.)	**Residential:** Hands=A grade, dermal/inhalation=ABC . Hand = 15 replicates; dermal/inhalation = 30 replicates. Medium confidence in dermal and inhalation data, high confidence in hand data.

a Some of the assumptions are from Standard Operating Procedures (SOPs) for Residential Exposure Assessment.

b These grades are based on Quality Assurance/Quality Control data provided as part of the exposure studies. A replicate refers to data acquired during one complete work cycle. All handler exposure assessments in this document are based on the "Best Available" data as defined by HED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments.) Best

available grades are assigned as follows: matrices with grades A and B data (which is defined as acceptable grade data) and a minimum of 15 replicates; if not available, then grades A, B, and C data and a minimum of 15 replicates; if not available, then all data (all grades) regardless of the quality and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection.

Data confidence as reported in the Table refers to both the quality and the quantity (number of replicates) of data for each PHED run. Each study in PHED has been graded from A to E. A high confidence run is grades A and B data and 15 or more replicates per body part. Any combination of A and B grade data are listed as acceptable grades data in the tables. A medium confidence run is grades A, B, and C data and 15 or more replicates per body part. Any combination of A, B, and C grade data are listed as ABC grade data in the tables. A low confidence run is all grades (any run that includes D or E grade data) or has less than 15 replicates per body part.

c Clothing for residential scenarios is short pants, short-sleeved shirt, no gloves, open mixing/loading. Accounting for the use of PPE is not considered appropriate in residential risk assessments, as the Agency can only make recommendations to residential handlers regarding the use of PPE.

Table 4: Post-Application Risks to Public Following Acephate Application to Turf in FL (5.0 lb ai/A – 2 applications) [ACEPHATE]

Scenario	Exposed Individual	Application Rate Per Treatment (AR) (lb ai/A)[a]	TTR (ug/cm^2)[b]	GRt (ug/cm^2)[c]	Transfer Coefficient (Tc) (cm^2/hr)	Exposure Time (ET) (hrs/day)	Dermal Abs. (%)	Surface Area (SA) (cm^2/ event)	Freq. (FQ) (events/ hr)	Saliva Extrac. (%)	IgR (cm^2/day)	BW (kg)	ADD (mg/kg/day)[e]	MOE[f]
Dermal exposure	Adult	3.5	0.20	-	14,500	2	100	-	-	-	-	70	0.083	140
	Child				5,200							15	0.14	86
Hand-to-Mouth	Child	3.5	0.20	-	-	2	-	20	20	50	-	15	0.0053	94
Turfgrass ingestion	Child	3.5	-	0.20	-	-	-	-	-	50	25	15	0.00017	2900

a Maximum application rate for residential turf = 3.5 lb ai/acre.

b Turf transferable residue = 0.289 ug/cm^2 * 3.5 / 5.0 (ratio of application rates) = 0.20 ug/cm^2; Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application of registrant's study and corrected for application rate of 3.5 lb ai/A.

c Grass residue = TTR (ug/cm^2); assumed to be equivalent.

d Ingestion rate: cm^2/day for grass ingestion

e Average daily dose (ADD) (mg/kg/day)
Dermal exposure: = [TTR (ug/cm^2) * Tc (cm^2/hr) * mg/1,000 ug * ET (hrs/day) * absorption factor (1.0)] / [BW (kg)];
Hand-to-mouth: = [TTR (ug/cm^2) * SA (cm^2/event) * FQ (events/hr) * mg/1,000 ug * ET (2 hrs/day) * SE (0.5)] / [BW (kg)];
Turfgrass ingestion: = [GRt (ug/cm^2) * IgR (cm^2/day) * SE (0.5) * mg/1,000 ug] / [BW (kg)].

f MOE = NOAEL / ADD where acephate $NOAEL_{dermal}$= 12 mg/kg/day and acephate $NOAEL_{oral}$ = 0.5 mg/kg/day ; the dermal NOAEL is used to calculate the dermal MOE and the acute oral NOAEL is used to calculate the hand-to-mouth, and turfgrass ingestion MOEs. MOE of 100 is an acceptable margin of exposure.

Table 5. Post-Application Risks to Public Following Acephate Application to Turf in FL (5.0 lb ai/A – 2 applications) [METHAMIDOPHOS]

Scenario	Exposed Individual	TTR (ug/cm^2)[a]	GRt (ug/cm^2)[b]	Transfer Coefficient (Tc) (cm^2/hr)	Exposure Time (ET) (hrs/day)	DermalAbs. (%)	Surface Area (SA) (cm^2/ event)	Freq. (FQ) (events/ hr)	Saliva Extrac. (%)	IgR (cm^2/day)[c]	BW (kg)	ADD (mg/kg/day)[d]	MOE[e]
Dermal exposure	Adult	0.00074	-	14,500	2	100	-	-	-	-	70	0.00031	2400
	Child			5,200							15	0.00051	1500
Hand-to-Mouth	Child	0.00074	-	-	2	-	20	20	50	-	15	0.000020	15000
Turfgrass ingestion	Child	-	0.00074	-	-	-	-	-	50	25	15	0.0000006	500000

a Turf transferable residue = 0.00106 ug/cm^2 * 3.5 / 5.0 (ratio of application rates) = 0.00074 ug/cm^2; Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application of registrant's study and corrected for application rate of 3.5 lb ai/A.

b Grass residue = TTR (ug/cm^2); assumed to be equivalent.

c Ingestion rate: cm^2/day for grass ingestion.

d Average daily dose (ADD) (mg/kg/day)
Dermal exposure: = [TTR (ug/cm^2) * Tc (cm^2/hr) * mg/1,000 ug * ET (hrs/day) * absorption factor (1.0)] / [BW (kg)];
Hand-to-mouth: = [TTR (ug/cm^2) * SA (cm^2/event) * FQ (events/hr) * mg/1,000 ug * SE (0.5) * ET (2 hrs/day)] / [BW (kg)];
Turfgrass ingestion:= [GRt (ug/cm^2) * IgR (cm^2/day) * SE (0.5) * mg/1,000 ug] / [BW (kg)].

e MOE = NOAEL / ADD where methamidophos $NOAEL_{dermal}$= 0.75 mg/kg/day and $NOAEL_{oral}$= 0.3 mg/kg/day; the dermal NOAEL is used to calculate the dermal MOE and the acute oral NOAEL is used to calculate the hand-to-mouth, and turfgrass ingestion MOEs. MOE of 300 is an acceptable margin of exposure.

Appendix D Acephate Non-Occupational (Recreational) Exposure and Risk Assessment Tables (Short-Term Exposures)

Table 1. Non-Occupational Risk Assessment for Adult Golfers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications)

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average TTR ($\mu g/cm^2$)	Adult Golfer Dose (mg/kg/day)	MOE	Average TTR ($\mu g/cm^2$)	Adult Golfer Dose (mg/kg/day)	MOE
0	0.289	0.0016	7500	0.00106	0.000006	125000

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). It is assumed that golfers are wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

Adult Golfer Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (100 cm^2/hr for golfing) * (4 hr/day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight. NOTE: this does not include possible hand-to-mouth exposures.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Table 2. Non-Occupational Risk Assessment for 13+ Year-Old Golfers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications)

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average DFR ($\mu g/cm^2$)	13+ Golfer Dose (mg/kg/day)	MOE	Average DFR ($\mu g/cm^2$)	13+ Golfer Dose (mg/kg/day)	MOE
0	0.289	0.0026	4620	0.00106	0.0000096	78100

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). It was assumed that children golfers are wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

13+ Year-Old Golfer Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (100 cm^2/hr for golfing) * (4 hr/day) * (1mg/1000 μg conversion factor) ÷44 kg Body Weight. NOTE: this does not include possible hand-to-mouth exposures.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Appendix E Review of Acephate and Methamidophos Incident Reports

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
EVENTION, PESTICIDES AND
TOXIC SUBSTANCES

September 8, 1999

MEMORANDUM

SUBJECT: Review of Acephate Incident Reports, DP Barcode 247487, Chemical #103301, Reregistration # 0042

FROM: Ruth H. Allen, Ph.D., M.P.H. Environmental Scientist (Health)
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

Jerome Blondell, Ph.D., M.P.H., Health Statistician
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

THRU: Francis B. Suhre, Senior Scientist
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

TO: Felecia Fort, Chemist
Reregistration Branch 1
Health Effects Division (7509C)

BACKGROUND

In response to the request that Health Effects Division Epidemiology Group review the incident data on acephate, a search of the published epidemiology literature was conducted, and the following data bases were reviewed for the poisoning incident data on the active ingredient acephate:

1) **OPP Incident Data System (IDS)** - reports of incidents from various sources, including registrants (required under Federal Insecticide Fungicide and Rodenticide Act (FIFRA) Section 6(a)(2)), other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the

Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) **American Association of Poison Control Centers (AAPCC)** - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 60-70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc. In addition, EPA purchased data for the time period 1993-1996 for all pesticides.

3) **California Department of Pesticide Regulation** - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) **National Pesticide Telecommunications Network (NPTN)** - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

ACEPHATE REVIEW

I. Incident Data System

There are two types of incident information on file for acephate: (A) *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D. Letter to Jerome Blondell, Office of Pesticide Programs, September 3, 1998, and (B) routine reporting to the Incident Data System (IDS).

A. *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D.

A 24 year old male pesticide applicator with no prior history of any cardiac difficulties died suddenly after spraying seven homes with a mixture of acephate and dicofol. A medical review of the applicator's autopsy report, clinical toxicology findings, and results of cholinesterase tests on his tissues were requested by EPA. Dr. Wagner, Professor of Clinical Toxicology at Oregon State University and medical advisor to the

Epidemiology Group concluded that “the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication.”

On the day of his death, the pesticide applicator was mixing and applying organophosphate insecticide without proper protection, and with a particulate mask that would have increased his risk of inhaling increased concentrations of the insecticide. At the seventh home he sprayed, he complained of headaches and collapsed. Attempts to resuscitation failed and he was declared dead one half hour after admission to the emergency room. His stomach contents and urine were negative for drugs and other substances. Dr. Wagner concluded that he had died with documented ventricular fibrillation, the most common type of cardiac arrhythmia occurring with organophosphate insecticides.

Details of the lab assay methods and storage stability of the enzymes were reviewed with three authorities, and these findings and the presence of anticoagulants EDTA was evaluated by Dr. Wagner who concluded that “an abnormally low cholinesterase confirmed significant exposure and /or intoxication from acephate.” Dr. Wagner concluded that “the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication.”

B. Incident Data System (IDS) Routine Reporting for Acephate.

Acephate human poisoning incidents are reported for multiple geographic locations, by several companies, and for a variety of uses and formulations. Only those cases involving a moderate, major, or fatal outcome are summarized below. Certain large compilations of cases (e.g., packages numbered 1264, 1827, 3268, 3326, 3380, 3474, 3844, and 4007) that duplicate information collected by Poison Control Centers and covered elsewhere in this review are also excluded from the section below.

Incident #732-1

In September 1992, in Florida a female scout in tomato fields developed dizziness, weight loss, headaches, vomiting, spots before her eyes. She did not seek medical attention immediately, but symptoms persisted and she was hospitalized a few days or weeks later (time not specified). Some of her symptoms have reportedly persisted for months since this incident. No further information on the disposition of this case is available.

Incident #2969-5

In 1995 an incident was reported involving inhalation and respiratory inhalation that was classified as having a moderate outcome. No further information on the disposition of this case is available.

Incident #2969-7

In 1995 an incident occurred where inhalation of acephate reportedly led to headache, difficulty breathing, and pain in the chest. No further information on the disposition of this case is available.

Incident #2969-34

In 1995 an incident occurred when a human was exposed (route of exposure unknown) and became semi-conscious. No further information on the disposition of this case is available.

Incident #2969-59

In an undescribed incident which led to a lawsuit, an injury was alleged from re-entering a place where acephate had been used. No further information on the disposition of this case is available.

Incident #3599-1

The Minnesota Department of Agriculture surveyed state enforcement agencies to determine what pesticides were involved in spray drift. Among the 32 states responding to the survey, there were a total of 2,681 cases of drift complaint. Acephate was responsible for 19 complaints or about one percent of the total.

Incident #4535-1

An incident occurred in 1996 when dermal exposure to a 62 year old led to lethargy, coughing/choking, pulmonary edema, respiratory irritation, and fever. No further information on the disposition of this case is available.

II. Poison Control Center Data - 1985 through 1992

Acephate was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) ratios of poisonings and hospitalization for PCC cases to estimated number of containers used in U.S. homes; and [C] number and percent of child exposures to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects.

A. Occupational and Non-occupational Exposure

From 1985-1992, there were a total of 3,004 acephate cases in the PCC data base. Of these, 334 cases were occupational exposure; 208 (62%) to acephate alone and 126 (38%) involving exposure to multiple products including acephate. There were a total of 1,996 exposures to adults and children six years old or older; 1,753 (88%)

involving acephate alone and 243 (12%) with multiple products.

In this analysis, four measures of hazard were developed based on the Poison Control Center data, as listed below.

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).

2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.

3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

4. Percent of those cases with outcome determined that had a major medical outcome (defined as life-threatening or permanent disability) or death.

Exposure to acephate alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1. Measures of Risk From Occupational and Non-occupational Exposure to Acephate Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single product exposure	63.0 (68.2)	27.7 (44.0)
Multiple product exposure	66.5 (69.8)	29.8 (46.1)
Percent Hospitalized		
Single product exposure	12.2 (12.2)	6.0 (9.9)
Multiple product exposure	14.9 (14.3)	6.9 (12.6)
Percent with Symptoms		
Single product exposure	87.9*[7] (85.8)	67.5 (74.0)
Multiple product exposure	87.8 (85.8)	69.8 (75.2)
Percent with Life-threatening Symptoms		
Single product exposure	0.8[b] (0.0)	0.2[b] (0.0)
Multiple product exposure	0.5[b] (0.5)	0.3[b] (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.
b The percents calculated for the occupational category are based on a single life-threatening case. For non-occupational exposures to a single product, there were 2 life-threatening cases and 1 fatality. The percents calculated for non-occupational exposure to multiple products, included these 3 cases plus 2 more life-threatening cases.
* Top 25% of chemicals are ranked with a superscript of 1 to 7

Compared to other organophosphate and carbamate insecticides, acephate generally similar or somewhat below median levels for health care requirements and occurrence of symptoms. However, for life-threatening or fatal cases, the percents are above the median. The one fatality due to acephate was reported in 1990 involving a 67 year old who was exposed by route of inhalation due to accidental misuse.

B. Ratios of Poisoning - U.S. Poison Control Data

Active registrations of acephate are include significant residential uses. A comparison was computed for ten pesticides with significant home use between number of non-occupational exposures, poisonings and health care referral and the number of containers reported in U.S. homes. The results for acephate and the median for all 10 residential cholinesterase inhibitors included in the analysis are presented in the Table 2 below.

Table 2. Ratios of acephate exposures, poisonings, and cases referred to a health care facility (PCC Data, 1985-1992) to reported use in U.S. homes in 1990 (children under age six excluded)[a]

Pesticide	Exposure Per Use	Poisonings Per Use	Health Care Referral Per Use
Acephate	.461	.183	.150
Median	.790	.312	.320

a Extracted from Table 9 in the December 5, 1994 memo from Jerome Blondell to Joshua First
* Top 33% of chemicals are ranked with a superscript of 1 to 5

Among pesticides used widely in residential areas, acephate had ratios that were close to half the median (Table 2).

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For acephate, there were 674 incidents; 575 (85%) involved exposure to acephate alone. Compared to 16 other organophosphates and carbamates that 25 or more children were exposed to acephate cases were less likely to require medical attention. Acephate was also slightly less likely to result in related symptoms and there were no life-threatening or fatal cases in children under six years of age.

Poison Control Center Data - 1993 through 1996

Results for the years 1993 through 1996 are presented below for occupational cases, non-occupational involving adults and older children, and for children under age six. Unlike the earlier analysis for 1985-1992, cases involving exposures to multiple products are excluded. This is because the earlier analysis showed little difference in rankings and measurement of hazard when multiple exposure cases were included. Tables 3-5 present the hazard information for acephate compared with all other pesticides on six measures: percent with symptoms, percent with moderate, major, or fatal outcome, percent with major or fatal outcome, percent of exposed cases seen in a health care facility, and percent hospitalized and percent seen in a critical care facility. Table 3 presents this information for occupational cases, Table 4 for non-occupational cases involving adults and older children (six years or older), and Table 5 for children under age six.

Table 3. Comparison between acephate and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for occupational cases only

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	91.3%	20.3%	0%	46.0%	12.5%	9.38%
All Pesticides	85.9%	18.8%	0.60%	46.8%	7.18%	2.89%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

Table 4. Comparison between acephate and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for non-occupational cases involving adults and older children

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	69.5%	9.79%	0.16%	23.2%	9.43%	4.04%
All Pesticides	70.8%	10.8%	0.34%	18.7%	7.62%	3.36%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

Table 5. Comparison between PCP and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) for adults and children six years and older reported to Poison Control Centers, 1993-1996 for children under six years old

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	23.5%	1.53%	0%	15.0%	5.56%	1.85%
All Pesticides	22.3%	1.48%	0.13%	17.5%	5.47%	1.61%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

For non-occupational cases involving adults and older children or young children, acephate has a similar hazard profile to all other pesticides. Whether examining the symptomatic measures (SYM, MOD and LIFE-TH in the tables above) or health care-related measures (HCF, HOSP, and ICU) acephate had almost the same degree of hazard or perhaps a bit less hazard (e.g., health measures in Table 5). In contrast, hazards were noticeably higher for individuals exposed to acephate occupationally. This difference, however, was mostly limited to health care measures. Occupational acephate cases were 74% more likely to require hospitalization and three times more likely to be treated in an intensive care unit.

III. California Data - 1982 through 1995

Detailed descriptions of 259 cases involving acephate submitted to the California Pesticide Illness Surveillance Program (1982-1995) were reviewed. In 89 of these cases, acephate was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Acephate ranked 22nd as a cause of systemic poisoning in California. Table 6 presents the types of illnesses reported by year. Table 7 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 6. Cases Due to Acephate Exposure in California Reported by Type of Illness and Year, 1982-1995

Year	Illness Type				
	Systemic[b]	Eye	Skin	Respiratory	Total
1982	5	1	-	-	6
1983	3	2	1	-	6
1984	-	2	1	-	3
1985	2	1	-	-	3
1986	10	4	1	-	15
1987	1	1	-	-	2
1988	20	1	1	-	22
1989	2	1	1	-	4
1990	3	-	2	1	6
1991	8	-	-	-	8
1992	-	2	-	-	2
1993	1	3	-	-	4
1994	3	-	-	-	3
1995	4	-	-	1	5
Total	62	18	7	2	89

[b] Category includes cases where skin, eye, or respiratory effects were also reported
[c] Category includes combined irritative effects to eye, skin, and respiratory system

A total of 62 persons had systemic illnesses or 70% of 89 persons. A total of 22 workers took time off work as a result of their exposure to acephate, as shown in Table 7 below. A variety of worker activities were associated with exposure to acephate as illustrated in Table 8 below.

Table 7. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Acephate Exposure in California, 1982-1995

	Number of Persons Disabled	Number of Persons Hospitalized
One day	10	-
Two days	5	-
3-5 days	5	-
6-10 days	1	-
more than 10 days	1	-
Unknown	2	1

Table 8. Illnesses by Activity Categories for Acephate Exposure in California, 1982-1995

Activity Category	Illness Category				
	Systemic[b]	Eye	Skin	Respiratory	Total
Applicator	14	12	4	-	30
Mixer/Loader	-	3	-	1	4
Coincidental	3	-	-	-	3
Drift exposure	8	1	-	-	9
Field Residue	8	-	1	-	9
Other residue[a]	11	1	1	-	13
Manuf./Formulator	3	-	-	-	3
Other occupational	2	1	1	-	4
Non-occupational	13	-	-	1	14
Total	62	18	7	2	89

[a] Other Residue = worker exposed to residue neither agricultural nor structural.
[b] Category includes cases where skin, eye, or respiratory effects were also reported.

According to the above activity categories, applicators and other handlers accounted for over a third of the illnesses. Significant number of illnesses were also reported for workers exposed to spray drift and field residue. These illnesses included symptoms of dizziness, nausea, vomiting, chest tightness, eye and skin irritation, skin rashes, and incoordination.

One of the most common causes of acephate poisonings according to the California reports were spills in enclosed spaces, often from broken glass bottles. Approximately, one-third of the systemic illnesses could be ascribed to this cause.

Ratios of poisoning - California Data

The incidence of **systemic poisoning cases** in agricultural workers reported to the California was compared to the number of applications of acephate. Those calculations, along with the median score for a total of 29 pesticides, are presented in the Table 9 below.

Table 9. Systemic Poisonings/1,000 Applications in Selected Agricultural Workers Exposed to Acephate in California, 1982-1989[a]

Pesticide	Number of Applications	Poisonings/1,000 Applications (N) Primary Pesticide Only			Poisonings/1,000 Applications (N) Multiple Pesticide Exposure		
		Handlers	Field Workers	Total	Handlers	Field Workers	Total
Acephate	84,433	.04 (3)	.13 (11)	.17 (14)	.20 (17)	.20 (17)	.40 (34)
Median		.21	.20	.41	.44	.50	1.02

a Extracted from Table A5 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is the observed number of poisoned cases.

Acephate was not among the top five in ratio of field worker poisonings per 1,000 applications in California (see Table 7 in the December 5, 1994 memo.). Generally, the ratio of poisoning per thousand applications was well below the median, 80% lower for handlers and 35% lower for field workers exposures to acephate as the primary pesticide.

California accessed medical monitoring records for 542 agricultural pesticide applicators under medical supervision in 1985 for exposure to the more toxic cholinesterase-inhibiting organophosphate and carbamate pesticides (Ames et al. 1987, 1989) . In California, cholinesterase monitoring is required for all pesticide applicators who handle Toxicity Category I or II organophosphate or carbamate pesticides for 30 hours of more in any 30 day period. To be included in the survey, the worker had to have at least one pre-exposure (baseline) cholinesterase measurement and at least one exposure value (mid-season). A data-call-in was issued by the California Department of Food and Agriculture and local Agricultural Commissioners through pesticide application firms to their medical supervisors. Follow up letters were sent and phone calls made to employers, physicians, and laboratories performing tests, but significant under reporting is likely to have occurred. Therefore, these workers may not be representative of all workers undergoing medical monitoring in California. However, they do represent exposure effects verified by medical laboratories. Cholinesterase activity depression of 20 percent or more below baseline was observed in 127 or 23 percent of the 542 workers. Depression of 20 percent or more below

baseline represents strong evidence of exposure (Gallo and Lawryk 1991).

Specific pesticide exposure was available for 94 of the 127 cases, based on usage records for the previous two weeks. Of these, 31 percent had been exposed to mevinphos, 21 percent to methomyl, and 21 percent to parathion, the three leading pesticides responsible for cholinesterase inhibition. Of the 94 cases with inhibition, 16% had exposure in the past two weeks to acephate. Note that many of the workers were exposed to two or more pesticides during the two weeks before they had cholinesterase depression of 20% or more. Twelve of the workers in this study were reported to have pesticide-related illnesses by their physicians. These data demonstrate that agricultural workers, who mix, load and apply the more toxic pesticides are subject to significant levels of exposure despite the considerable restrictions in place to prevent exposure.

IV. NPTN

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, acephate ranked number 13 and was reported to be involved in 254 human incidents and 24 animal incidents.

V. Summary/Conclusions

When both Poison Control Center and California data were considered, acephate generally had a lower hazard than other organophosphate and carbamate insecticides. There have been two accidental deaths reported associated with exposure. Both deaths involved misuse and in one case use of a particulate mask may have increased the risk of inhaling acephate. Minor and moderate symptoms of exposure have often been associated with inhalation indoors. Outdoor agricultural use are associated with lower risks of illness and poisoning than most other organophosphate and carbamate insecticides.

VI. Recommendations

Indoor use of acephate should be restricted to certified Pest Control Operators. Homeowner products should be limited to only products that are either ready-to-use or mostly diluted product. The one exception to this should be hose-end sprayers and other concentrates that can be used by homeowners without mixing or pouring. Acephate should be sold in non-breakable containers.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
EVENTION, PESTICIDES AND
TOXIC SUBSTANCES

September 9, 1999

MEMORANDUM

SUBJECT: Review of Methamidophos Incident Reports
DP Barcode D258608, Chemical #101201

FROM: Jerome Blondell, Ph.D., Health Statistician
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THRU: Francis B. Suhre, Senior Scientist
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TO: Susan Hanley, Chemist
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BACKGROUND

The following data bases have been consulted for the poisoning incident data on the active ingredient Methamidophos (PC Code:101201):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident

Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 60-70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc. In addition, as the result of a data purchase by EPA, OPP received Poison Control Center data covering the years 1993 through 1996 for all pesticides.

3) California Department of Pesticide Regulation - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Pesticide Telecommunications Network (NPTN) - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

METHAMIDOPHOS REVIEW

I. Incident Data System

Please note that the following cases from the IDS do not have documentation confirming exposure or health effects unless otherwise noted.

Incident#960-1

A pesticide incident occurred in 1994, when an Italian man intentionally swallowed 45.6 grams of methamidophos in a 200 ml solution (estimated dose = 600 mg/kg) in a suicide attempt. He became comatose with cholinesterase level less than 10 percent of normal, which indicates a life-threatening poisoning. With treatment he recovered, however on day 25 weakness developed in his legs. Tests of nerve conduction velocities, evoked potentials, and neuro-toxic esterase confirmed a chronic case of peripheral neuropathy. Other such cases have been reported in the literature.

Incident#2195-4

A pesticide incident occurred in 1995 in California, when twenty-two field workers were weeding an alfalfa field that was treated the day before. Twelve workers experienced nausea and vomiting and sought medical care and two of the workers were admitted to the hospital for twenty-four hours. Enforcement action was taken for not properly posting the field to prevent worker entry. No further information on the disposition of the case was reported.

Incident#4158-1

A pesticide incident occurred in Idaho in 1996 when methamidophos drifted on to a garden. The owner of the garden was told not to eat the vegetables but entered the garden and was exposed by direct contact with the foliage. She was reportedly affected in a manner that persisted for 14 days. However, her symptoms were not reported. No further information on the disposition of this case was reported.

Incident#4215-9

A pesticide incident occurred in 1996, when the chemical got onto a thirty year old's skin and they experienced diarrhea, nausea, and headaches. No further information on the disposition of the case was reported.

Incident#4215-17

A pesticide incident occurred in 1996, when an individual inhaled the chemical and experienced headaches. No further information on the disposition of the case was reported.

Incident#6107-9

A pesticide incident occurred in 1997, when a thirty-eight year old individual experienced ocular irritation and pain. No further information on the disposition of the case was reported.

Incident#6532-4

A pesticide incident occurred in 1997, when an individual experienced agitation, irritation, and uncontrolled anger. No further information on the disposition of the case was reported.

Incident#6869-1

A pesticide incident occurred in 1997, when an aerial applicator applied methamidophos and chlorothalonil to a potato field and thirteen workers were exposed. As a result, one worker is claiming health problems and seeing a doctor daily, and another worker experienced coughing, green phlegm, headaches, and sinus problems. Neither victim reportedly had symptoms typical of organophosphate poisoning. No further information on the disposition of the case was reported.

Incident#7441-1

A pesticide incident occurred in 1998, when ten females were working on an apple field across the road from a potato field that was sprayed with methamidophos and several other chemicals. The workers experienced difficulty breathing, swelling of the tongue, nausea, headaches, vomiting, blurred vision, cough and respiratory irritation. Six of the workers were hospitalized for one night. No further information on the disposition of the case was reported.

Incident#7587-157

A pesticide incident occurred in 1996, when a twenty-two year old male experienced nausea, dizziness, weakness, and throat irritation after methamidophos and chlorothalonil were sprayed aerially about three hundred feet away. No further information on the disposition of the case was reported.

II. Poison Control Center Data - 1985 through 1992

Methamidophos was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture; and [C] number and percent of child exposures to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects.

A. Occupational and Non-occupational Exposure

From 1985-1992, there were a total of 121 methamidophos cases in the PCC data base. Of these, 41 cases were occupational exposure; 33 (80%) to methamidophos alone and 8 (20%) involving exposure to multiple products including methamidophos. There were a total of 74 exposures to adults and children six years old or older; 63 (85%) involving methamidophos alone and 11 (15%) with multiple products.

In this analysis, four measures of hazard were developed based on the Poison Control Center data, as listed below.

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).

2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.

3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

4. Percent of those cases with outcome determined that had a major medical outcome (defined as life-threatening or permanent disability) or death..

Exposure to acephate alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1. Measures of Risk From Occupational and Non-occupational Exposure to Methamidophos Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single product exposure	75.8 (68.2)	55.6 (44.0)
Multiple product exposure	80.5*[7] (69.8)	60.8 (46.1)
Percent Hospitalized		
Single product exposure	16.0 (12.2)	14.3 (9.9)
Multiple product exposure	24.2*[7] (14.3)	20.0*[6] (12.6)
Percent with Symptoms		
Single product exposure	95.0*[3] (85.8)	80.0 (74.0)
Multiple product exposure	96.2*[2] (85.8)	80.0 (75.2)
Percent with Life-threatening Symptoms		
Single product exposure	5.0*[2b] (0.0)	0.0 (0.0)
Multiple product exposure	3.8*[2b] (0.5)	0.0 (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.
b The percents calculated for the occupational category are based on a single life-threatening case.
* Top 25% of chemicals are ranked with a superscript of 1 to 7.

Compared to other organophosphate and carbamate insecticides, methamidophos has a greater hazard in terms of percent developing symptoms, life-threatening symptoms (for the occupationally category only and based on a single case), and greater requirements for health care. In a combined ranking based on all four measures, methamidophos ranked second out of the 28 chemicals (mevinphos ranked first). Similarly, for the non-occupational category methamidophos ranked sixth out of 28 insecticides. The first or highest ranked insecticide was the one associated with the highest combined risk on the various measures.

B. Ratios of Poisoning - U.S. Poison Control Data

Active registrations of methamidophos are used primarily in agricultural settings. A comparison was computed for 15 pesticides with primary agricultural use between number of occupational exposures, poisonings, health care referrals and hospitalizations and the number of pounds active ingredient reported in use for 1989-1991. The results for methamidophos and the median for all 15 agricultural cholinesterase inhibitors included in the analysis are presented in the Table 2 below.

Table 2. Ratios of methamidophos exposures, poisonings, and cases referred to a health care facility (PCC Data, 1985-1992) to thousands of pounds active ingredient reported in use[a]

Pesticide	Exposure Per Use	Poisonings Per Use	Health Care Referral per Use	Hospitalizations Per Use
Methamidophos	.036	.022*[5]	.029	.007*[5]
Median	.033	.013	.027	.004

a Extracted from Table 9 in the December 5, 1994 memorandum from Jerome Blondell to Joshua First.
* Top 33% of chemicals are ranked with a superscript of 1 to 5

Among pesticides used principally in agricultural settings, methamidophos had higher ratios than other cholinesterase-inhibiting insecticides. The ratios of poisonings and hospitalizations per pounds active ingredient reported in use ranked fifth among the 16 insecticides that were compared (Table 2).

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For methamidophos, there were 6 incidents; 5 involved exposure to methamidophos alone. Just one of these cases was seen in a health care facility. This number of cases was too small to warrant a more detailed evaluation.

Poison Control Center Data - 1993 through 1996

Results for the years 1993 through 1996 are presented below for occupational cases. Only 12 exposures were reported to be non-occupational in adults and older children, too few to warrant more detailed analysis. Of these 12 cases, six were seen in a health care facility, but none were hospitalized. Only three exposures were reported for children under age six, too few to warrant more extensive analysis. Unlike the earlier analysis for 1985-1992, cases involving exposures to multiple products are excluded. This is because the earlier analysis showed little difference in rankings and measurement of hazard when multiple exposure cases were included. Table 3 presents the occupational hazard information for methamidophos compared with all other pesticides on six measures: percent with symptoms, percent with moderate,

major, or fatal outcome, percent with major or fatal outcome, percent of exposed cases seen in a health care facility, and percent hospitalized and percent seen in a critical care facility

Table 3. Comparison between methamidophos and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for occupational cases only

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Methamidophos	90.0%	10.0%	0%	76.0%	10.5%	0%
All Pesticides	85.9%	18.8%	0.60%	46.8%	7.18%	2.89%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

For occupational cases, methamidophos had only ten cases where outcome was determined. Therefore, differences in percents given in Table 3 are unlikely to be significant. Of 25 occupational exposures, 19 were seen in a health care facility and 2 of these cases required hospitalization. This suggests a higher requirement for health care but based on relatively few cases.

III. California Data - 1982 through 1994

Detailed descriptions of 158 cases submitted to the California Pesticide Illness Surveillance Program (1982-1994) were reviewed. In 71 of these cases, methamidophos was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Methamidophos ranked 19th as a cause of systemic poisoning in California for this time period and 8th for cases involving only agricultural workers. Table 4 presents the types of illnesses reported by year. Table 5 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 4. Cases Due to Methamidophos Exposure in California Reported by Type of Illness and Year, 1982-1994

Year	Illness Type				
	Systemic[b]	Eye	Skin	Combination[c]	Total
1982	-	-	-	-	-
1983	6	-	1	-	7
1984	5	-	1	-	6
1985	3	-	-	-	3
1986	31	-	-	-	31
1987	-	-	-	-	-
1988	14	-	1	-	15
1989	1	-	-	-	1
1990	1	-	1	-	2
1991	2	-	-	-	2
1992	2	-	-	-	2
1993	-	-	-	-	-
1994	-	-	2	-	2
Total	65	-	6	-	71

[b] Category includes cases where skin, eye, or respiratory effects were also reported
[c] Category includes combined irritative effects to eye, skin, and respiratory system

Table 5. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Methamidophos Exposure in California, 1982-1994

	Number of Persons Disabled	Number of Persons Hospitalized
One day	3	-
Two days	6	1
3-5 days	5	2
6-10 days	15	1
more than 10 days	11	-
Unknown	5	1

A total of 65 persons had systemic illnesses or 91.5% of 71 persons. A variety of worker activities were associated with exposure to methamidophos as illustrated in Table 3 below.

Table 6. Illnesses by Activity Categories for Methamidophos Exposure in California, 1982-1994

Activity Category	Illness Category				
	Systemic[b]	Eye	Skin	Combination[c]	Total
Applicator	1	-	-	-	1
Mixer/Loader	7	-	1	-	8
Drift exposure[a]	19	-	1	-	20
Field residue[a]	32	-	4	-	36
Commodity residue	2	-	-	-	2
Other	4	-	-	-	4
Total	65.00	-	6.00	-	71.00

[a] Drift exposure included 11 school instructors adjacent to a broccoli field being sprayed in 1988. Field residue included 25 workers in a cotton field that had been sprayed that morning.
[b] Category includes cases where skin, eye, or respiratory effects were also reported
[c] Category includes combined irritative effects to eye, skin, and respiratory system

According to the above activity categories, field residue was associated with the majority (51%) of the exposures. Twenty-five of the cases occurred after a cotton field was sprayed with methamidophos earlier in the morning. Drift exposure was also a problem with methamidophos, accounting for 28% of the illnesses. The earlier 1994 review (December 5, 1994 memo from Jerome Blondell to Joshua First) found that methamidophos ranked highest for number of field workers poisoned (either by spray drift or field residue) per 1,000 applications from 1982 through 1989.

Weinbaum et al. (1997) analyzed risk factors for systemic illness in California for organophosphates for the time period 1984 through 1988. In their analysis they used the ratio of number of systemic illnesses to the pounds applied. Methamidophos was among five organophosphates that had statistically significant increased risk of poisoning. The estimated increase was 1.6 with a 95 percent confidence interval of 1.2 to 2.0. Only mevinphos, demeton, and oxydemeton-methyl had higher estimated ratios.

IV. National Pesticide Telecommunications Network

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, methamidophos was ranked 91st with 39 incidents in humans reported and 2 incidents in animals (mostly pets).

V. Literature

Rosenstock et al. (1991) performed a retrospective cohort study of agricultural workers in Nicaragua who had been hospitalized with organophosphate poisoning. Of 52 eligible patients hospitalized over a two year period, 38 men were located, and 36

agreed to participate in the study. Of the 36 who agreed to participate, 21 had been previously poisoned by methamidophos. Controls were a close male friend or sibling from the same community who had never been treated for pesticide poisoning and was no more than 5 years different in age from the case participant. Both members of the pair (case and control) were examined during May-June 1989 before the onset of the 4-5 month spraying season. Six of the seven tests from the World Health Organization core neurobehavioral test battery were administered, along with a brief symptom inventory, 6 additional Spanish-translated tests, and a 16 item self-reported symptom inventory. These tests were administered an average of 2 years after the time of hospitalization for poisoning.

Poisoned workers scored significantly worse on five of the six WHO core neurobehavioral tests, 3 of the 6 Spanish-translated tests, and the 16 item self-reported inventory. Deficits were noted in auditory and visual attention, visual memory, visuomotor skills, steadiness and dexterity. These findings replicated, to a large degree, those of Savage et al., which is an important consideration when judging the weight of evidence for a conclusion that OP poisoning is a cause of chronic neurobehavioral effects.

McConnell et al. (1994) evaluated vibration threshold in 36 Nicaraguan workers poisoned by organophosphate insecticides (the same cohort studied by Rosenstock et al. above). All of the workers had been poisoned and hospitalized from one to three years prior to this study. Of the 36 workers, 21 had been poisoned by methamidophos. The group poisoned by methamidophos had higher mean vibration thresholds than those (n = 15) poisoned by other organophosphates who also had higher mean thresholds than the unexposed control group (each exposed case was matched to a sibling or friend with the same sex and age within five years). These differences were largest in the lower extremities. Testing for suspected confounders (e.g., recent pesticide exposure, history of solvent exposure, and history of work with vibrating machinery) did not alter these results. The authors concluded “These results strongly suggest a chronic sensory impairment resulting from methamidophos poisoning.”

Karalliedde et al. (1988) reported on a 22 year old pregnant woman who ingested methamidophos with suicidal intent. It was estimated that she was 36 weeks pregnant at the time. She had severe poisoning and received treatment three hours after the ingestion, including atropine, pralidoxime, and required mechanical ventilation for six days. Forty-four days after the intoxication she delivered a healthy boy with a birth weight of 2.85 kg (6.2 pounds). The authors attribute the healthy baby to prompt and adequate management of the life-threatening phases of the poisoning.

McConnell and Hruska (1993) reported on an epidemic of 548 pesticide poisoning in northwestern Nicaragua during June and July 1987. Of the 548 cases 91% were occupational, 8% involved other accidents, and 1% were suicide attempts. Of the occupational cases, one-third were due to methamidophos.

Senanayake and Karalliedde (1987) reported on a life-threatening sequelae to

organophosphate poisoning which they referred to as an intermediate syndrome. They observed 10 patients that had paralysis of the proximal limb muscles , neck flexors, motor cranial nerves, and respiratory muscles 1-3 days after poisoning. One of the ten patients was poisoned by methamidophos (suicide attempt) and required mechanical ventilation. The weakness persisted for 32 days which overlapped the development of a delayed polyneuropathy. In an earlier report of a series of 27 patients with delayed neuropathy (Senanayake 1985), 25 were caused by methamidophos.

Sun et al (1998) reported that methamidophos was responsible for half of the pesticide intoxications and fatality cases in China. A total of 553 intoxications due to dermal exposure to methamidophos and 104 cases by ingestion from 1987 through 1992 among 5 hospitas in rural China. They reviewed the medical records of 104 subjects that had been poisoned by ingestion (mostly attempted suicides) and performed in-person interviews and medical examinations with 100 of these subjects and interviewed relatives of the remaining four. Among the 104 cases, 14 cases of organophosphate-induced delayed polyneuropathy (OPIDP) were identified. Six of the 14 cases had ingested a mixture of methamidophos and dimethoate. In 13 of the 14 OPIDP cases the initial poisoning was severe (12 cases exhibited coma and 3 suffered from urine and feces incontinence). All 14 cases were confirmed by severely inhibited blood cholinesterase. All 14 OPIDP cases complained of paralysis and reeling gait. Most OPIDP cases recovered within two years of their intoxication.

Goh et al. (1990) reported on an outbreak of food poisoning in Singapore which occurred in 1988. A total of 105 cases of illness among those who had consumed gai-lan vegetables were treated at hospitals during the December 3-7 period. Among 68 cases examined at one of the hospitals, 98% exhibited vomiting, 67% reported abdominal cramps, 65% diarrhea, 37% nausea, 63% giddiness, 31% excessive sweating, 30% blurred vision, 19% headache, and 12% muscle twitching. Testing of the suspected vegetables identified 2.4-31.7 ppm methamidophos, 1.1-5.4 ppm profenofos, and 4.1-16.8 ppm dithiocarbamate fungicide. The authors noted “the higher acute toxicity of methamidophos, together with its 5 times higher level of residue detected in the vegetable, would evidence that methamidophos was mainly responsible for the poisoning.” The authors go on to estimate the total ingestion by assuming 10% of the highest combined level of methamidophos and profenofos residues remained after cooking and washing and that the average person eats 150 grams, giving an ingestion of 0.56 mg per person. Blood cholinesterase levels were depressed 26-81% below normal in five of the hospitalized patients who were tested.

Chan et al. (1996) reported there were 47 outbreaks of food poisoning in Hong Kong in 1992, all of which were caused by methamidophos. An estimated 329 people were affected. The authors estimated that these food-borne poisoning exceeded the incidence of pesticide poisonings that were not related to dietary intake by five-fold.

VI. Conclusions

Based on Poison Control Center data methamidophos ranked second out of 28 cholinesterase-inhibiting insecticides on combined measures of hazard. Similarly for non-occupational cases (typically bystanders or other workers not directly involved in application), methamidophos ranked sixth. An earlier review of California data found that methamidophos had the highest risk of field worker poisoning per 1,000 applications but that this was influenced by large clusters. For example, in one incident 25 workers were poisoned in a cotton field that had been treated that morning, a clear violation of the required reentry waiting period. Overall combining California and Poison Control Center data rankings, led to methamidophos being ranked third (after mevinphos and carbofuran) for combined measures of hazard.

VII. Recommendations

Methamidophos probably poses one of the highest risks to workers of any organophosphate insecticide currently registered. Significant reductions in hazard to workers would result from cancellation of most uses. Where safer alternatives are not available, a full set of restrictive measures including posting, closed-mixing loading, reentry restrictions, and buffer zones to prevent drift to nearby workers or residential areas should be instituted.

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Appendix F Documents Used in the Acephate Human Health Risk Assessment

Information from the following memoranda were incorporated into this human health assessment.

1. Acephate: Revisions of the Toxicology Chapter for the RED Document to Include Comments from the Registrant and Other Interested Members of the Public/Formal Response to the Comments Received form the Registrant and Other Interested Members of the Public; Nancy McCarroll, 6/9/99, DP Barcode D256734.

2. Acephate: Support for the Toxicological Endpoint Selection For Dermal Risk Assessments; Nancy McCarroll, 6/20/99; HED Doc. No. 013613.

3. Acephate: Hazard Identification Committee Report; George Ghali, 01/05/98, HED Doc. No. 012453; 01/15/98.

4. FQPA SAFETY FACTOR RECOMMENDATIONS FOR THE ORGANOPHOSPHATES: A Combined Report of the Hazard Identification Assessment Review Committee and the FQPA Safety Factor Committee, Brenda Tarplee and Jess Rowland, 8/6/98.

5. Acephate: Revised Occupational and Non-Occupational Exposure and Risk Assessments for the Reregistration Eligibility Decision (RED) Document; Catherine Joseph; 1/20/00; DP Barcode D262573.

6. Review of Acephate Incident Reports, Ruth Allen and Jerome Blondell, 9/8/99, DP Barcode D247487.

7. Acephate: Revised Product and Residue Chemistry Chapters for the Reregistration Eligibility Decision. Felecia Fort, 10/5/99, DP Barcode D259662.

8. Acephate**.** Revised Dietary Exposure Analysis for the HED Revised Human Health Risk Assessment, Felecia Fort, 9/28/99, DP Barcode D254604.

9. Acephate Use Closure Memo, Lois Rossi, 12/23/97, no DP Barcode.